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NOTES FOR THE MONTH.

Wheat Cultivation: Climate, Soils and Varieties.

In view of the assertion often made by farmers that their land is not suitable for wheat growing, it is instructive to review the climatic and soil conditions under which the crop flourishes. The range of climatic conditions is greater than with most other food plants, extending from within the tropics to the northern limits of the temperate zone. Growth throughout such a wide range of latitude and on such widely different types of soil is, of course, possible, owing to the large number of species and varieties cultivated, and it shows that wheat is a wonderfully hardy and adaptable plant.

So far as Great Britain is concerned, wheat growing is confined mainly to the Southern, Midland and Eastern Counties of England and to the eastern fringe of Scotland, the reason being that these regions are, as a rule, best suited to the wheat commonly grown in this country and to the systems of farming in which wheat occupies a place otherwise difficult to fill. In other regions other cereals are better adapted to the farming systems in vogue or give a better return on outlay. Experience of the war years, however, discloses the fact that wheat may often be successfully grown in the most unexpected places.

To give the best results wheat requires a fairly high summer temperature and a moderate annual rainfall. It will thrive on almost any soil, even the light "heath" land of Norfolk, provided that the requisite "condition" is first built up and maintained. Excellent crops may be grown on the heaviest and most intractable of clays if the drainage be adequate and

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the cultivation skilful. Wheat is specially favoured on heavy land because it can be sown in autumn when the requisite tilth is usually more easily secured than is the case later for spring-sown crops. Strong loams are admirably adapted for wheat in regions of comparatively low summer rainfall. In wetter districts light soils, if in good condition, will answer the purpose equally. The main considerations from the farmers' standpoint seem to be such conditions of soil and fertility as will ensure steady growth until the plant is thoroughly established. Thereafter the crop is much less dependent on rainfall than either oats or barley.

Treatment of different Types of Soil.—Heavy soils are improved for wheat growing by drainage (both under-draining and, when necessary, surface draining) and by liming: by half fallows and in certain cases by summer fallows. The requisite plant food can be supplied either in the form of artificial manures applied directly to the crop or in the form of crop and manurial residues incidental to rotational cropping.

In the case of the lightest soils, fertility and the requisite "body" must be built up by the use of manures applied to green crops for folding or ploughing in, by the growth of clover and other leguminous crops, or by a system of short-term leys.

Medium soils must likewise be well farmed, for wheat occupies the ground for a relatively long period and requires adequate and uniform sustenance throughout its life.

Varieties.—Although many, if not most, of the varieties commonly grown in this country are about equally well suited to the generality of conditions encountered, a few may be worth noting in regard to their adaptability. On cold and heavy soils in poor physical condition, varieties of the Rivet type usually do as well as any. The grain is of rather poor quality, but the straw is long, coarse and tough and well suited to withstand the most adverse weather conditions. Rivet wheat, however, must be sown early, and is not suited to late districts.

For general average conditions Victor, Wilhelmina, Little Joss, Browick, Squarehead's Master and similar varieties are generally dependable.

On very rich soils Yeoman or Swedish Iron may be safely trusted. They will stand up well and thresh well. Yeoman gives a better quality grain.

For light soils probably no variety is more suitable than Little Joss.

Winter Oats.

FARMERS who contemplate extending their wheat area should arrange, if possible, not to reduce the acreage under oats, for this grain may be just as useful as wheat, and the straw is of value as fodder. In many districts, particularly the south of England, the Frit-fly, sometimes called "bottling," has made spring oats a precarious crop. It is, therefore, well to sow the winter grain, or Black Oats, about the end of March, as these are more reliable than the commoner spring sorts, especially on grass land just ploughed and in districts troubled by the Frit-fly. Winter-sown oats are less liable to attack by this pest, and are worthy of increased attention. They are also better adapted to land badly infested with charlock.

The three varieties of winter oats generally favoured are Winter Grey or Dun Oat, Winter Black and Bountiful Black Oat. Experience must guide choice, for all may grow equally well in one district, but a particular variety may happen to be in keener local demand. The Black varieties are somewhat stronger in straw than the Grey, and are preferable on land subject to "lodging." The Winter Black Oat is more liable to shed its seed, and should be cut before it is dead ripe. It does not give such a palatable straw as the finer spring varieties, but stock will readily eat it chaffed and mixed with cake or meal. Winter oats suit a wide range of soils, and can be grown successfully on land too poor or too light for wheat. They can also be taken for a second crop on clean land. They are less hardy than winter wheat or barley, and must be sown early, preferably in September, so as to get well established before the cold weather. "Bountiful" is the most delicate of the three varieties, and should be reserved for the milder districts: it requires a somewhat richer land than the others. In preparing the soil for winter oats, it is well to leave it somewhat rough as a protection against cold winds, and in certain ground harrowing may be omitted after drilling. Clean land is essential, as weeds may seriously reduce the crop. Among troublesome weeds, the Brome Grass is noteworthy, and purchasers should see that their seed oats have been carefully cleaned. Winter oats are best suited to the warmer southern counties, and are generally fit for cutting about 10 days before other corn crops.

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Schools for Women's Institute Organisers.

WOMEN'S Institutes have from the outset been based on the principle of self-government. During the short period when Institutes were still only finding their way as a national movement, assistance was given by the Ministry.

The Women's Branch of the Ministry was made responsible, for a period of about eighteen months, for the development of the organisation throughout the country. This, however, was only a temporary arrangement, and was intended to be so, from the outset, as it was obvious that the permanent strength of the movement rested upon the basic principle of self-government. When the Women's Branch was no longer responsible for propaganda work, the Ministry, who recognised the value of Women's Institutes to the rural life of the country, decided that it would be well to secure a high standard of work among those responsible for the further development of the movement. Treasury sanction was, therefore, obtained to form two schools of instruction for Women's Institute organisers, which should be held, if possible, at "University" centres and last for at least a fortnight. By this arrangement, Organisers are given an opportunity of meeting the leading men and women at the Universities and of learning from them. Short as the sessions must be, such schools will undoubtedly quicken interest in the subjects discussed, while the lecturers will be able directly to encourage and suggest further lines of study.

Of the organisers employed by the National Federation of Women's Institutes, a small number are paid, full-time officers, who explain Women's Institute work in the villages, organise new Institutes, and perform much valuable after-care work. In addition to paid organisers, a considerable number of women who have knowledge of Women's Institute principles and methods and who can give a certain portion of their time to develop the movement in their own counties, have been appointed voluntary organisers to the Federation. From both these classes, 40 students have been selected for the Ministry's Schools of Instruction. The first School opened on 20th September and closes on 2nd October, at Oxford, where Professor Somerville and Mr. Ashby of the School of Rural Economy gave every facility, both as regards lecturers and accommodation. The second school will be open at the University College of Wales, Aberystwyth, from 18th to 30th October. Principal Davies and his staff are taking active interest and are giving generous assistance in the school.

The main subjects dealt with in these schools are connected, in the first place, with agriculture, in its historical and more general aspects; and, in the second place, with the facts and possibilities of local government, so that village women may understand more of what is really available for the life of the community through the county, district and parish councils. Other important subjects are village recreations, home-making and hygiene, and the principles and methods of voluntary organisation, with special reference to Women's Institutes. Thanks to the response given by the authorities at both Oxford and Aberystwyth, some of the best University lecturers have been secured—Mr. Ashby, Mr. C. S. Orwin and Mr. C. G. T. Morison at Oxford, and Professor E. A. Lewis, Mr. J. Morgan Rees, Mr. Sidney Herbert, Dr. R. O. Morris, Mr. Bryner Jones and Professor Abel Jones at Aberystwyth. In addition, Dr. Walford Davies is giving a lecture at the Aberystwyth School on "Music in the Villages"; while at Oxford the students will have the advantage of hearing Mr. Cecil Sharp on "The Purpose of Art," and Miss Avice Trench on "Home-making and Hygiene." The Ministry is also fortunate in having secured the services of Miss Grace Hadow, Vice-Chairman of the National Federation, to arrange lectures at both schools on "Voluntary Organisation," and especially the organisation of the Women's Institute movement itself.

The lectures—never more than two each day—will be followed by an hour's open discussion.

A number of outside events have been planned. These include visits to the University Farm at Oxford and the new Plant Breeding Station at Aberystwyth, as well as functions of a more social character to places of interest in the University and neighbourhood.

At Aberystwyth, the students will have the opportunity of attending Dr. Walford Davies's annual musical festival and his Thursday evening concerts at the University. Dr. Lund, of the Department of Agriculture, Washington, will give a demonstration at Oxford on the American way of preserving food in the home, and will speak on agricultural extension work in the United States at an open meeting. The Council of Bernett House, Oxford, is placing the library of that Society at the disposal of the students, and a list of books and pamphlets dealing with rural questions will be available.

Arrangements have been made for the organisers attending both schools to lodge in one house, and not the least value

of the schools will be the opportunity thus afforded for those attending the different lectures to meet together in a friendly manner and discuss the subjects of the lectures and the future of the movement.

Shorthand notes of lectures and discussions will be taken, from which a report will be made, and will doubtless prove of great interest and value to all workers in the Women's Institute movement as well as to others interested in the improvement of rural life.

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Renovation of Neglected Orchards.

MANY acres of orchard land in England and Wales have fallen into a deplorable state of decay. The causes of unprofitableness are many. Some are beyond remedy, but others are preventable, and fruit-growers would be serving their own interests as well as the interests of the country if they made a serious attempt to bring neglected orchards back to productiveness; but the work must be undertaken with judgment. It is not commercially sound to restore plantations and orchards which have become unprofitable owing to extreme old age, stunted growth, or severe damage caused by live stock, careless staking, or grease-banding without paper. On the other hand, many dilapidated plantations and orchards may be restored to fruitfulness if their unsatisfactory state is due to lack of pruning, proper cultivation, or neglect to control insect and fungus pests. Even if the trees are unsuited to the locality, or bear fruit of poor market quality, much may be done, and done speedily, by judicious top-grafting. The results of renovation may become apparent even so early as the year following the first application of remedial measures, but as a general rule careful treatment is requried for several seasons before badly neglected or otherwise unfruitful trees are brought back to full bearing.

Renovation falls into two sets of operations. These are:—

(1) Thinning overcrowded plantations by judicious pruning, top-grafting, manuring and general cultivation.

(2) Cleaning the trees and controlling insect and fungus pests by winter washing and summer spraying.

To remedy overcrowding, alternate trees should first be "cut-in" hard each year, and, later, after several seasons have elapsed, "grubbed up" to give the permanent trees sufficient room for growth. Plantations and orchards which have

become badly overcrowded should receive very drastic treatment. Nothing less than the removal of alternate trees will be of permanent value. Many orchards and plantations have lapsed owing to the entire neglect of winter pruning. There is a great tendency to treat "Standards," in particular, as ordinary shade trees, and to assume that they are quite capable of looking after themselves. "Standards" and "Half-Standards," it is true, cannot be dwarfed or forced in the same way as cordon and bush trees, and in these cases, therefore, spur-pruning is unsuitable. The proper method is to adopt the simple system of thinning the heads. This is done by removing all crossing branches and strong growths arising from the centre of the tree and shortening those branches which tend to become spindly and unable to bear a heavy crop without breaking. The head then remains well balanced. It can be effectively sprayed, while sunlight and air can penetrate to all parts, so that the fruit colours and the wood ripens satisfactorily. The heads of trees that have not been winter-pruned for several years are usually mere thickets, and, therefore, contain practically no fruiting wood except on the outside. Apples which have been thus neglected should be top-grafted with a strong growing variety, but pears, plums, cherries and apples not badly overcrowded should be very carefully thinned, the operation extending over several years, so that there will be no risk of killing the tree by a very severe check.

Insufficient manuring is a common cause of unfruitfulness, and is most difficult to remedy. It occurs very frequently in grass orchards. Poverty-stricken trees are easily recognised by their light-yellow leaves, small annual growth, and the "unkind" hide-bound appearance of bark, trunk and branches. While grass may in certain cases impair the health of young trees, it will serve, in the case of older plantations on strong land, to check excessive growth, and will promote heavy fruiting. Grass should always be kept closely grazed, especially with sheep fed on meal, and a dressing of basic slag at the rate of 5-10 cwt. per acre will give good results on heavy soils. This should be applied every four or five years. Ground lime also has a good effect. Special attention must be paid to the winter washing of fruit trees. Caustic washes are most satisfactory for trees in a thoroughly bad condition. Lime sulphur washes may be used between November and February, and lime washes, applied usually in early spring, just before the buds break, are effective in destroying insect pests.

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THE Seeds Act, 1920, received Royal Assent on the 16th August, but does not come into operation until the 1st August, 1921. The object of delaying the date on which the Act comes into force is to allow the Seed Trade ample time to study the regulations which will in future govern the sale of seeds in this country.

The Seeds Act, 1920.

The passing of this Act makes permanent one of the farthest-reaching minor reforms in the interests of good agriculture—that effected by the Testing of Seeds Order, a measure passed under the Defence of the Realm Regulations. The Testing of Seeds Order, 1917, which came into operation on the 1st January, 1918, brought the United Kingdom into line with the Continent, America and the Colonies, where for a number of years various regulations have been in force for the purpose of preventing the sale of seeds of low vitality and seeds containing a dangerous proportion of injurious weeds. In 1816 regulations were in force in Switzerland which enabled Government Inspectors to enter any seed shop or warehouse for the purpose of examining the seeds offered for sale. Cases of fraud were suitably dealt with. In 1871, E. Müller Holst initiated a system of control of seeds in Denmark and founded his seed testing office.* Then followed the setting up of various methods of seed control in Holland, Hungary, Germany, the United States of America and a number of the British colonies. The first official Seed Testing Station in the United Kingdom was established in Ireland in 1900; and by the passing of the Weeds and Agricultural Seeds Act, which applied to Ireland only, at a later date (1909) the Irish Department was given a certain measure of control over the sale of seeds. Early in 1914 the Board of Agriculture for Scotland established a seed testing station, but no legislative control of seeds was attempted.

The main object of the Testing of Seeds Order was to protect the farmer against the danger of unknowingly purchasing and sowing seeds of low vitality and contaminated with noxious weed seeds. No attempt was made to force the farmer to use seed of a better quality than that which he was ready to buy; the aim was to compel the seller to disclose certain essential facts so that the purchaser could judge the value of the seed with a fair degree of accuracy.

The original Order was replaced on the 1st July, 1918, by the Testing of Seeds Order, 1918,† which widened the scope of the

* See this *Journal*, July, 1920, p. 367.
† See this *Journal*, July, 1918, p. 477.

first Order and made it applicable to all the principal kinds of cereals, grasses, clovers, roots and vegetable seeds. It requires that a declaration as to the percentage of germination and purity, presence of injurious weeds and other specified particulars, shall be made in writing to the purchaser at or before the time of sale or delivery of the seed.

This Order will remain in force during the forthcoming (1920-21) season and until the Act comes into operation on the 1st August next.

The main provisions of the new Act are as follows:—

1. The Minister of Agriculture is empowered to make regulations for carrying the Act into effect, scheduling the kinds of seeds to which the Act shall apply, laying down the manner in which samples are to be taken and dealt with, and any matter under the Act which is to be prescribed.

In dealing with an article which is subject to the changing conditions of season and method of handling, as in the case of seeds, any attempt to incorporate in the Act complete details of the control to be exercised would greatly hinder efficient administration. It is clearly desirable, therefore, that regulations should be issued from time to time to keep the requirements in touch with new conditions.

The Act provides that the Minister shall consult with "representatives of the interests concerned" before making regulations, and every regulation must be laid before each House of Parliament in the usual manner.

The first set of Regulations is now under consideration, and will be issued as soon as possible.

2. In the case of a sale of any seeds to which the Act applies and of any seed potatoes the seller must, at or before the time of sale or delivery, make a statement to the purchaser containing the prescribed particulars as to the variety, purity and germination in the case of seeds, and as to class, variety, size and dressing in the case of seed potatoes.

The particulars which it is proposed shall be given in the case of a sale of seed potatoes are similar to those required under the Seed Potatoes Order, 1918.* Seed potatoes are not covered by the Testing of Seeds Order. Other seeds, such as forest tree seeds and fibre flax seed, not included under the Testing of Seeds Order, will be scheduled under the Act.

* See this *Journal*, January, 1919, p. 1235.

3. Seeds and seed potatoes exposed for sale must have a statement containing the prescribed particulars "displayed conspicuously or in close proximity to the seeds or potatoes."

4. In the case of seeds, other than garden seeds, the test for the purpose of ascertaining the particulars to be declared by the seller must be carried out at an Official Seed Testing Station or at a private testing station which has been licensed by the Minister of Agriculture for this purpose.

   (Particulars as to the conditions under which a private station may be licensed will be issued at a later date.)

5. The test must have been carried out not earlier than the 1st August immediately preceding the date of sale, except in the case of seeds sold or exposed for sale during the month of August or September, when the test must have been made not earlier than the 1st August in the previous year.

6. The sale or sowing of seed containing above a prescribed percentage of injurious weed seeds is prohibited.

7. Authorised Inspectors of the Ministry may enter any premises where seeds or seed potatoes are sold or stored and take samples for the purpose of having check tests carried out at the Official Seed Testing Station.

8. A copy of the certificate of the result of the official check test will, in any proceedings against the owner of the seeds, be conclusive evidence of the facts therein stated.

9. The Act does not apply to a sale of seeds under the following conditions:—

   (*a*) When sold to a person "purporting to purchase seeds with a view to cleaning them before they are sold or exposed for sale."

   (*b*) When the purchaser gives the seller "an undertaking in writing that before selling or exposing the seeds for sale he will test or cause them to be tested."

   This exemption is made to cover a sale of seeds through a "string" of merchants. It enables such seed to be passed from merchant to merchant without the necessity of a fresh test and fresh declaration being made in each case.

   (*c*) When sold for delivery outside the United Kingdom, and

(*d*) When sold for some purpose other than for planting or sowing.

10. A purchaser of any seeds who desires a test to be made for the purposes of civil proceedings must within 10 days of delivery take a sample and divide it into two portions; one part to be sent to the Official Seed Testing Station for testing, and the other part to be delivered or tendered to the seller.

11. The Act also sets forth the penalties for failing to comply with the requirements laid down or for tampering with samples, but the prosecutions can be instituted only by the Minister.

12. The Act provides that separate official seed testing stations may be established for England and Wales, Scotland and Ireland, respectively, but it is permitted that there should be a central Testing Station for the whole of the United Kingdom or for any two parts.

13. The Act applies to Scotland and Ireland as well as to England and Wales, with the exception that the internal seed trade of Ireland will continue to be regulated under the Weeds and Agricultural Seeds (Ireland) Act, 1909.

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Agricultural Prices.

Much has been said of the material benefit which farmers have derived from the rise in prices of all agricultural produce during and since the war period, and it cannot be denied that the agricultural interest has enjoyed a measure of comparative prosperity. It must, however, be remembered that there are two sides to every account, that while in the early days of the War the farmer's lot was very substantially eased, over the whole period the rise in the value of produce has been accompanied by a marked rise in the cost of materials such as fertilisers, feeding stuffs, seeds and agricultural implements, while at the same time the current rates of wages constantly increased and by the end of 1919 had more than doubled. These facts are lucidly set out in the Report on Prices and Supplies just issued by the Ministry.*

It is pointed out that a comparison of the movement in the money values of these different types of receipts and expendi-

* Agricultural Statistics, 1919, Vol. LIV., Part III. Prices and Supplies of Corn, Live Stock and other Agricultural Produce in England and Wales, and Summaries of Colonial and Foreign Agricultural Statistics. Cmd. 902, 1920. 6d. net. Obtainable from H.M. Stationery Office, Kingsway, London, W.C.2.

ture will not afford any true estimate of the extent to which the increased returns have been counterbalanced by the additional outlay on cost of production. A rough comparison, however, is of interest as showing how, in common with other industries, the increased returns from sales of produce have been accompanied by higher costs of production. In making such a comparison the average prices of the three years 1911—1913 have been taken as a fair basis for the pre-war period. On that basis a table of percentages has been drawn up to illustrate the changes in the war period as compared with the years 1911—1913 for each of the main products sold by farmers. In all cases the price of an average quality has been selected.

From these calculations it appears that the price for cattle, which in 1914 showed an increase of 6 per cent., rose in a gradually ascending scale to 132 per cent. in 1919. Milk rose from 3 to 200 per cent., sheep from 13 to 130, pigs from 6 to 176, wheat from 7 to 123, wool from 9 to 208, butter from 1 to 115, oats from 5 to 164, cheese from 4 to 169, beans and peas from 8 to 219, and vegetables from 8 to 157. Hay, which in 1914 showed a decrease of 23 per cent., increased in 1915 to + 6 per cent. and in 1919 to + 157. Barley, which decreased 4 per cent. in 1914, had risen in 1919 to + 167. In 1914 potatoes dropped 15 per cent., but immediately recovered, standing finally at 135 per cent. above the pre-war average. Poultry and eggs dropped 2 per cent. in 1914, but at the end of the period in question had risen to + 159 per cent. Fruit, which in the first two years of the War showed decreases of 16 and 5 per cent. respectively, rose in 1916 to + 38 and in 1919 to + 218. Hops in the first four years were respectively 54, 32, 19 and 9 per cent. below the 1911-13 average. In 1918 the increase had mounted to 93, and in 1919 to 113, per cent. above the pre-war average.

On a general view, measuring the change by an index number which takes into account not only the actual alterations in price but the relative importance of the various products in contributing to the farmers' exchequer, the percentage increase for the years 1914—1919 as compared with 1911—1913 shows the following progression per annum:—1, 27, 60, 101, 132, 158. This means that in 1914 there was practically no change, while in 1915 the increase amounted only to 27 per cent.; in each of the three following years prices rose very sharply by 30 to 40 per cent. of the pre-war average, and in the year of the Armistice they stood at 132 per cent. above

the pre-war level. In 1919 the upward movement continued, but the rate of increase was somewhat checked.

Turning to the other side of the account, the prices of farm requisites, we find the following changes. Milling offals in 1914 rose 3 per cent., and in 1919 stood at 130 per cent. above the level in 1911-13; barley meal and maize meal advanced from an increase of 5 to one of 191 per cent. Linseed and cotton seed cakes, which dropped by 5 per cent. in 1914, immediately thereafter recovered and finally stood at 186 per cent. over the pre-war average. Maize, with an initial rise of 2, finally touched 147 per cent. Brewers' grains, after a drop of 9 in 1914, reached in 1919 a price 173 per cent. above that of 1911-13. Sulphate of ammonia, having dropped 13 and 5 in the first two years, rose to + 19 per cent. in 1916 and in 1919 stood at + 18 per cent. Nitrate of soda, after a fall of 4 per cent. in the first year, went as high as + 156 per cent. in 1918 and in 1919 was marked at 114 per cent. above the 1911-13 average. Basic slag, showing no change in 1914, rose at length to 110, and superphosphate advanced from 3 to 165 per cent. over pre-war rates. It is shown that whereas the average cost of the principal artificial manures, excluding lime, was in 1911-12 £3 19s. per ton, in 1918-19 it rose to £6 18s. 9d., and in 1919-20 to £8 14s. 6d. per ton—an increase of 121 per cent. as compared with 1911-12. Seeds and machinery also show a very considerable increase in price, although it is difficult to estimate with any accuracy as the quantities purchased are not known.

The farmer's problem was complicated by the marked advance in wages, and it is calculated that the average increase by the end of 1919 was to be measured by a figure between 130 and 140 per cent. as compared with pre-war rates. To sum up, the general rise in the price of farm produce sold was about 158 per cent.: feeding stuffs increased by 184, fertilisers by 121, seeds by 140, and machinery and implements probably by 94 per cent., while the cash wages advanced to the figure already stated—130 to 140 per cent. above pre-war rates. It is manifest that the better prices which the farmer obtains are to a very large extent set off by the increased cost of what he has to buy.

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The Improvement of Moorland Pasture.

THE improvement of moorland pasture formed the main subject of a lecture given by Professor D. A. Gilchrist, of Armstrong College, Newcastle-on-Tyne, to farmers at Skipton on 6th September, under the auspices of the Ministry's grassland campaign.

The mountain and heath land in England and Wales used for grazing extends, it was pointed out, to over four million acres, and while a large proportion of this area is not capable of improvement (especially such as is bare rock or poor peat), considerable patches of better moorland pasture are to be found which are better eaten off by grazing stock, and which usually contain small clovers and other leguminous plants in their herbage. Much of our present moorland was under cultivation many years ago, and such areas, together with the better areas of virgin moorland, are those on which improvement is likely to be possible.

Examples of Improvement by the Use of Basic Slag.—Professor Gilchrist took as examples two moorland farms in the Hexham district. The first farm is about 750 feet above sea level, is 360 acres in area, and consists half of virgin moor and half of moor formerly under cultivation. Excellent meadow hay is now grown on this farm as the result of suitable dressings of basic slag and dung; and marked improvement has been obtained on virgin moor within two years by the application of 10 cwt. per acre of high grade basic slag. The difference between slagged and unslagged moor is very striking.

The second moorland farm is at an altitude of nearly 1,000 feet, and is 1,130 acres in area. Sandstones of the Millstone Grit are the main underlying rocks, and the lower land of the farm lies chiefly on Boulder Clay, with occasional smaller areas of Glacial Sands. Much of the land has moorish peat on the first few inches of the surface. On this farm, where clover and other leguminous plants exist, basic slag has largely developed such herbage, and consequently the grass herbage as well. One enclosed area has received two dressings of basic slag in the past ten years, and has now excellent grass and clover herbage, while, immediately beyond the wall of the enclosure, the moor is of a poor character, producing little but heather and similar plants. On the unenclosed moorland basic slag has improved quite large areas, which are well distributed in order to encourage the grazing stock to keep

moving over the moor; special attention is given to this practice, as it results in the whole moor being better grazed and consequently improved.

The following plan of management is to be adopted on the latter farm:—

(1) About 50 acres mown annually for hay will receive, if possible, a dressing of 10 tons of dung per acre every fourth year, with about 7 cwt. per acre of high grade basic slag (or the equivalent quantity of lower grade) every fourth year. Such combination of slag and dung for meadow land has been most successful at Cockle Park, and it is certain to be so on moorland farms. The quantity of hay should be increased, the nutritive value improved, and the autumn and winter grazing should be of a much more valuable character.

(2) About 7 cwt. per acre of high grade basic slag (or the equivalent of low grade) will be applied every fourth year on all the enclosed pasture land on this farm (except the poorer and more mossy pasture).

Grazing with both Cattle and Sheep.—Sheep reject herbage of a benty character and graze only the fine bottom herbage, which they bite very closely, so that pasture grazed with sheep alone becomes rough and benty. Cattle graze more evenly and not so closely, and their heavier treading is also a great advantage. At Cockle Park pastures treated similarly in other respects produced live weight gains of 200 lb. per acre per annum when grazed with a mixed stock of cattle and sheep, and only about 100 lb. when grazed with sheep alone.

Grazing by cattle is further beneficial in that it does much to prevent the accumulation of dead and matted organic matter on the surface. Such matter makes improvement especially difficult on much moorland, because basic slag in such cases has no chance to penetrate to the soil underneath.

It is therefore of great importance that more cattle should be kept on moorland farms.

High Grade Basic Slag and Mineral Phosphates for Moorland.—The difficulty of access to moorland increases the cost of conveying manures for application, so that the highest grade manures obtainable should be used. Professor Gilchrist made a strong plea for the reservation of a certain proportion of our highest grades of basic slag for moorland improvement. He also referred to the phosphatic deposits of the Island of Nauru, surrendered by Germany, which are said to be capable of pro-

viding 80 to 100 million tons of high grade phosphate rock in all, and an annual supply of 400,000 tons. Ground phosphates have given most satisfactory results in the improvement of pasture, and should trials of Nauru phosphate prove a success a phosphatic manure will be available at least 50 per cent. richer in phosphates than our highest grade basic slag, and of the greatest value for the improvement of moorland.

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THE following notes on the winter feeding of poultry have been contributed by the Harper Adams Agricultural College, Newport, Salop:—

Winter Feeding of Poultry.

The present scarcity of foodstuffs makes proper and adequate feeding difficult. Good feeding corn is practically non-existent, and the mixtures available are not only high in price but very inferior in quality, and if it is at all possible are better avoided. There is a certain quantity of maize available. Crushed oats can also be procured, but many of the samples contain an undue percentage of Black Tartarian. Good sharps are difficult to obtain at an economical price, although where procurable they represent better value for money than do the poorer qualities.

Breeding Stock.—Such birds should now be fed with a view to getting them safely through the moult and in a hard condition for the breeding pens in two months' time. Where the moult has not started they should be put on a low non-forcing diet, so that they may be thrown into a moult as soon as possible. All soft food should be discontinued and corn only fed until the moult starts. Afterwards the birds should be fed liberally in order to build up their strength rapidly in readiness for the possible bad weather that may soon set in.

Young Stock.—Liberal feeding will be well repaid. Scalded fish meal and bran, dried off with crushed oats and sharps with enough milk (whole or skimmed) to make the mass crumply moist will be the most economical soft feed. Wheat, clipped oats and kibbled maize in the proportion of 2 : 2 : 1 makes an expensive but satisfactory corn feed. Smutted wheat should be avoided, as it will cause the birds to scour. Vegetables, either cooked or raw, should be fed with the soft food. Not only are they essential to the health of the birds, but they will bulk the food very cheaply and reduce the cost per head. A dusting of charcoal in the soft food is decidedly beneficial.

Birds in Laying Houses.—Corn scattered in litter the first

thing in the morning and last thing at night gives excellent results. The quantity should be ¾ oz. per bird in the morning and 1¼ oz. per bird at night. A suitable mixture would be wheat, oats and kibbled maize in the proportion of 2 : 2 : 1. Soft feed should be given at mid-day, to include plenty of vegetables, cooked or raw; bran 1 part; fish meal 2 parts; crushed oats 4 parts; and sharps 8 parts. Soft food should be mixed the previous evening. Grit and shell should be continuously before all birds; the average consumption by a bird in full lay is 8½ lb. per annum.

Surplus Cockerels.—The aim with surplus cockerels should be to get the birds as heavy as possible, although unless a "killing" trade exists it is questionable whether they will repay much trouble and expense. As soon as they reach a marketable size they should be penned and fed for three weeks with a view to putting on flesh. Equal quantities of crushed oats, barley meal and cooked potatoes may be fed, mixed with sour skimmed milk. This represents a cheap mixture to finish off the birds where no special fattening facilities exist.

A small quantity of greaves, up to ½ oz. per bird, may be gradually introduced into the mixture.

The cockerels should be starved for 24 hours after penning, and sold at the end of three weeks, as after that time the birds rapidly lose condition.

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Winter Egg Production.

HATCHING operations have at this time of the year for the most part ceased, and the young stock reached a stage requiring less frequent attention. The detection of the sexes among the March and April hatched chickens that will provide the pullets for the production of eggs during the winter months is by now within the powers of any novice, and the numbers for which provision has to be made can be easily ascertained. A very important point to remember is that no more birds than can be properly accommodated should be retained. It is far more economical to sell off some of the pullets than to overcrowd the houses or pens. Surplus pullets command a ready sale at good prices, and if reared in adequate space will improve greatly in quality.

Except for small flocks enjoying a good range and a sheltered position, the birds should have a covered shelter in addition to the roost house. The extra expense entailed is well repaid, pro-

vided management in other directions is satisfactory. Houses and shelters could be repaired, cleansed and disinfected before the birds are placed in their winter quarters, and if still on range or on the chicken-rearing ground, they should be settled in these quarters by the end of September; indeed, the early part of that month is generally the most suitable time. The fowls become accustomed to the new conditions, and run less risk of being upset by a change made after they have begun to lay.

The birds should always be gently treated. Careful handling, quiet movement in tending, and avoidance of any usage that will frighten them should always be the aim of the attendant.

During bad weather, the proper exercise and occupation of birds under shelter is promoted by throwing grain among the dry litter on the floor of the shed. If no shelter be available and the birds have the benefit of a wider range, rough litter should be placed on one spot in the open with the same object in view, and grain thrown into it to encourage scratching. This is to be recommended, inasmuch as birds, even upon wide range during the winter months, frequently find little inducement in the shape of insect life or any natural food to tempt them far from their house, and, failing occupation, they return to the roost and mope on the perches. In this connection, it is necessary to call attention to a frequent mistake of the novice who, in his eagerness to keep the birds busy, over-does the exercise by hiding too effectively the grain or burying it in material too heavy to be turned over easily.

The question of food is particularly important. There is little risk of over-feeding where the diet is properly chosen. If the bird is so placed that no facilities exist for obtaining supplies from natural sources, greater skill is called for, but in any case Nature's supplies in the winter months are too scanty to provide material for egg production. This must be made good by extra attention to feeding.

Poultry keepers in the past looked upon grain and the products of grain as of the first, and sometimes of the only, importance. This question is now better understood, and the use of animal matter, meat or fish offals, blood, or meals prepared from these, is now known to be a necessity for winter egg production where insect life is absent. Vegetable food is of equal importance, and frequently part of the money which is spent upon grain would be far better invested in green food. Any kind of vegetable is valuable; turnips, swedes or occasional mangolds will answer in

the absence of green stuff. Grain, meal, animal and vegetable food must all be included in the diet of the pullet that is expected to produce winter eggs, but to secure production upon an economic basis, a due proportion of each, and the use of material which is not fit for human consumption, is required. House scraps afford most valuable food.

It is generally better to provide three sufficient meals a day than to surfeit the birds at any one meal. In the natural state fowls are intermittent feeders and will keep in a more healthy condition if fed in small quantities at short intervals. Where constant attention cannot be given, "dry mash" is particularly valuable. Airy, light quarters are a great factor in developing the production of winter eggs, while cleanliness of the houses and of the birds themselves is an essential condition.

Poultry-keepers should be warned not to "coddle" their birds. No harm will be taken by poultry let out in the open in any weather so long as they have broken fast before release, and have dry and sheltered quarters to which they can return. Birds shut up on bad days and only liberated under congenial conditions will fret, with consequent loss to their productive powers. Allowed out in any weather, poultry make full use of the shelter provided if it is sufficiently light and comfortable to attract them.

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Poultry on Stubbles.

THIS year, owing to the late season, labour troubles, the laying crops and consequent difficulty in harvesting, a larger amount of grain than usual has been left on the ground where the corn is cut. This will not be lost if poultry be placed on the fields after the corn has been carted. On many farms carrying a head of 200 to 300 fowls and a proper equipment of portable houses, the fowls are on the stubbles for six or eight weeks after harvest. It is customary to move them from one field to another. During their stay on the stubble no food is supplied, and the fresh ground and ample natural nourishment stimulate layers to renewed activity. Under such treatment the young stock make rapid progress, and the cost of a house may very speedily be repaid. More farmers might well take advantage of opportunities afforded in this direction. In every district some arrangement for placing fowls on the stubble should be possible between the farmer and neighbouring poultry keepers.

It is unfortunate that in districts where the depredations of foxes render the stubbling of poultry an impossibility, only

large flocks of turkeys or geese can be utilised. In such cases an attendant can be put in charge during the day and the flock driven home each evening.

Care should be taken not to overcrowd fowls in the houses, as the health of the birds suffers considerably from confinement all night long in the stuffy atmosphere, with a consequent loss in egg production.

The purchase of houses at the present high price is not always advisable, but in many instances a little time and ingenuity will provide what is necessary at very moderate expense. Rough erections in the corner of a field will afford all the shelter that is required by a fowl at this time of the year. To the right angle formed by two banks of earth a third bank of turves can be added, and a few sheets of iron, an old cart cloth, or similar covering used as a roof. To make the shelter proof against foxes or dogs, six-foot netting can be used to surround the construction. If repaired annually, such a shelter could be utilised for a number of years.

A very useful temporary fowl-shelter can be erected by driving a few stout posts into the ground and nailing to these a light frame, over which netting should be stretched. Bracken, straw or any other suitable material should be spread over the netting and a second layer of netting placed over the top. After use the straw can be removed and utilised in the yard, but the frame may be left standing ready for another year. Simple arrangements of this description should be so placed that the birds have access to several fields. In this way any special field not available for the poultry to run could be shut off with a roll or two of 3-ft. netting along the hedges. Less difficulty in stubbling fowls would then be experienced.

Quite apart from the use to which grain, otherwise lost, would be put, much is to be said for the benefit the land will derive from occupation by poultry. The manure is of great value, and the birds are very useful in keeping down insect pests, particularly the wireworm.

It is often objected that if the birds are in fields distant from the dwelling house attendance is difficult. There is also the risk from thieves, both human and four-footed, but when such risk is not serious the disadvantages are quite outweighed by the benefits received. In some instances it may not be necessary to close the trap doors at night. Not only is trouble thereby saved but it is an advantage to the birds to be out at daylight, and in some cases if necessary they may even be let

unattended for a day or two provided with sufficient water. Eggs would then be collected only every other day, but a visit is to be preferred.

Not infrequently it may be possible, by arranging with an employee who passes to and from his work, to close the houses at night and liberate the birds in the morning, or a schoolboy may be enlisted for this duty. If the flock is large and the weather hot, to obtain an adequate supply of water is sometimes a problem. Where the houses are portable a good method is to have a water cart and to move houses and cart together from field to field as the grain is cleared up.

Cleaning must not be neglected, and careful watch should be kept to ascertain that the birds are gleaning sufficient food. Their "crops" should be felt periodically at night. In prewar days it was not uncommon for a poultry keeper to pay a farmer from 3d. to 6d. per head for the privilege of placing his birds on the stubble, or, alternatively, in return for the use of the stubble, the farmer might be granted permission to use the poultry keeper's meadow for grazing sheep during autumn and winter.

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Agriculture and the new Railway Rates.

From the Rates Advisory Committee's Part II Report of 30th July, 1920, containing the revised railway rates, tolls and charges, the following information has been compiled as a guide to agriculturists, and it is hoped that it will lessen the difficulties that must inevitably follow a change in the system of charges which custom has made familiar. Broadly speaking, all the modifications and exceptions in favour of agriculture, incorporated in the revision which became operative on 15th January last, have been withdrawn as from 1st September, and agricultural material will be charged on a basis similar to that for other commercial commodities. There is, however, one notable exception to this general withdrawal of previous concessions, namely, for manure in bulk, packed manure, basic slag and lime conveyed by merchandise train in minimum loads of two tons for use as agricultural manure in the United Kingdom. For this traffic, the rates charged will be those in operation on the 14th January, 1920, with an addition of 50 per cent.

The following additions have been made in the rates for various commodities in which the farmer is interested:—

150 per cent. increase on parts of machines and other small parcels weighing 3 cwt. and under, when conveyed

by merchandise train. If conveyed by passenger train, the increase is 75 per cent.

The under-mentioned are subject to an increase of 100 per cent. plus a flat rate addition per truck, part truck or ton, with a maximum addition of 4s. per ton in the case of class A traffic. Details will be given on application to the railway authorities:—

Live stock, at truck rates or at head rates; grain and cake for cattle feeding; vegetables, including potatoes; agricultural machinery, other than parts already specified; returned empties, whether by passenger or goods train; basic slag; coprolites and rock phosphate—ground or unground; and pyrites, burnt or unburnt.

An increase of 75 per cent. is made in the case of:—

Milk and perishable merchandise, conveyed by passenger train.

Fifty per cent. increase with flat rate additions is added in the case of:—

Chalk, kelp, lime, limestone ground, manure, compost of manure, fish, gypsum, mucilage, sud cake, sugar scum, animal offals, fish offals, potash manures, salt, sea-sand, sodium sulphate, soot, spent hops, and certain refuse intended for manure.

At the same time, it is important to note that what is described as packed manure, together with basic slag and lime, conveyed by merchandise train for use as agricultural manure in the United Kingdom, enjoys a special concession. For this traffic the rates will be 50 per cent. above those in operation on 14th January, 1920, plus the flat rates, and are irrespective of distance. One important feature in this connection must not be overlooked. In order to take advantage of the concession, the fertilisers must be dispatched in loads of not less than 2 tons, and it is hoped that, where possible, full loads of 4 to 5 tons will be consigned. These "packed" manures are as follows:—

Nitrate and sulphate of ammonia, artificial manure, basic slag, blood or bones, calcium cyanamide, carbonate of lime, coconut refuse, flue-dust from blast furnaces and cement works; guano, kainit, leather shavings, nitrate and superphosphate of lime, nitrate of soda, sulphate of potash, shoddy dust, carbonised or not carbonised; shoddy manure, and willowers' waste refuse.

As the modified percentage additions apply only to fertilisers intended for agricultural purposes in the United Kingdom,

such traffic must be distinctly consigned "For agricultural use in the United Kingdom."

The information given here is not intended to act as a substitute for inquiries at the railway station, but as an aid to such inquiries.

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The Winter Storage of Potatoes and other Vegetables.

THE proper storage of vegetables adds greatly to the value of an allotment or cottage garden. Cultivators should plant varieties suitable for winter use and choose for late summer sowing such crops as beet, carrot and turnip, which will weather the winter in the ground. Vegetables which cannot be left should be harvested in good time and laid up in the proper way and during the right weather. Some should be stored dry, while others must be kept under such conditions as will check growth and at the same time prevent loss of moisture.

It is of the greatest importance to observe favourable conditions for the storage of potatoes, which are liable to wastage from four principal causes:—

1. Sweating and heating, due to insufficient ventilation:
2. Rotting, due to wet:
3. Injury from frost, due to insufficient protection:
4. Decay, caused by disease existing in the tubers at the time of storage.

Potatoes also deteriorate through sprouting and are liable to damage by rats and mice.

Where large quantities of potatoes have to be stored, a "clamp" or "grave" must be made, but for small quantities a cool, dry, frost-proof shed will be sufficient. In the shed the potatoes are spread in layers on the floor, and may be placed on a bed of straw or bracken. The layers of potatoes must not be more than $2\frac{1}{2}$ feet deep, lest heating and sprouting should ensue. After storage, an inspection should be made and any diseased specimens removed. The buildings should be rat-and-mouse-proof. Due care should be taken to exclude light by covering the potatoes with straw, litter or sacking, and the store-room should be ventilated periodically. In the absence of a suitable shed, quantities of less than one ton of potatoes may be stored in a "clamp." For small quantities the clamps should be in the shape of a cone built as high as possible, and well covered with as straight straw as can be obtained. Moderate amounts for household use may be stored in thick bags and kept in the larder. A sprinkling of quick-

lime and flowers of sulphur will help to keep down disease, for which it is well to be on the watch during late autumn. A good protection from frost is formed by throwing old sacking over the bags. In very severe weather, extra covering should be put on at night. In many houses there is a space beneath the roof which makes a good potato store in the absence of more convenient accommodation. If this is used, potatoes should be kept in boxes placed upon the rafters and protected with old sacking and several layers of crumpled newspaper. Cellars will also answer as potato stores, provided they are thoroughly dry and well ventilated. If the floor is damp the potatoes should be placed in boxes raised on bricks.

To store large quantities of potatoes out of doors, the best medium is the "clamp," which should be in the dryest part of the ground. A strip, 3 ft. 6 in. wide and long enough to take the potatoes, is marked out. After grading, the potatoes are piled in a heap, the two ends of which are triangular and upright. The sides and ends are covered with a layer of long wheat-straw, reaching almost to the top of the potatoes, and at the bottom well pressed down to the ground, as it is along the edge of the clamp that frost most easily enters. The ridge may be thatched over with a cover of long straw (wheat or barley, not oat) so that the ends overlap the straw covering at the sides. Rain will thus run off, and not into the clamp. At the approach of winter the heap is finished, except along the middle of the ridge, by covering it with a thick coat of soil dug out along the sides. This digging forms a drainage trench, from which an outlet should be cut to allow water to escape. Six inches of earth will give protection against moderate frosts, but it is advisable to put an extra three inches on the colder side. A thick layer of short litter should be placed upon the ridge. Unless decay occurs, the clamp may be left undisturbed until February.

Clamps of similar construction may be used for the storage of spring-sown beet, carrots, Jerusalem artichokes, parsnips, salsify and celery. Turnips are best left in the ground, but may be dug up at the approach of severe weather and "clamped" or buried in sand or ashes in a cool shed. Leeks, kohl rabi, Brussels sprouts, savoys, kale and spinach-beet should be left in the ground until required. Autumn-sown onions may be tied in ropes and slung in a cool, ventilated shed or laid two or three deep on battened shelves in an airy room. Vegetable marrows, if cut just before they are ripe and hung

in a cool, dry place, will keep for months. Herbs for flavouring should be dried, and the leaves rubbed off the wiry stalks and kept in well-stoppered bottles.

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The Development of Rural Industries.

THE county of Essex is setting a good example in the promotion of village handicrafts. At Coggeshall a tambour-lace industry has been established, and at Braxted the villagers have taken up doll-making. Classes of instruction and the actual practice of rural industries are carried on at Ingatestone, Dedham, Halstead, Kelvedon, Finchingfield and other centres. For the last ten years the Essex Handicrafts Association has furthered the work of instruction and organisation, and it is anxious to revive the ancient handicraft of rush-plaiting, still understood by some old residents who have preserved their skill, although the industry itself has fallen almost into disuse. It is proposed to encourage the older people to instruct the younger in the methods of what may be regarded as virtually a lost art.

Throughout the country the Home Arts and Industries Association is doing excellent work, and to this body many County Associations are affiliated. Instruction is given in modelling, casting, joinery, wood and stone carving, turning, carpentry, inlaying, brass and copper work, bent-iron work, hand-spinning and weaving, toy-making, embroidery, rug-making, pottery, leather work (embossed and cut), and basket-making. Many branches of the National Federation of Women's Institutes have also started village industries, and are finding a ready market for their wares. County Agricultural Committees, it is suggested, will be able to give valuable help in co-ordinating and furthering rural enterprise in handicrafts.

General advice and information as to the organising and conduct of societies is provided by the Rural Industries Branch of the Ministry.

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Jelly from Cider Apples.

DURING the coming winter the prices of jam and of sugar are certain to rule high. It is, therefore, not inopportune to recall particulars of a method by which a supply of apple jelly can be made cheaply. A few years ago, when the possibility of converting cider apples into jam or jelly was investigated in the laboratories of the National Fruit and Cider Institute at Long

Ashton, Somerset, it was found possible to produce a very palatable jelly without the addition of sugar or glucose, although, needless to say, better results are obtained if at least half the usual quantity of sugar is used. By following this method, a supply of home-made jelly can be simply and inexpensively made in districts where cider-apple juice is obtainable. The cider apples especially suitable are the sweet and bitter-sweet varieties. Sharp or sour varieties will, if used by themselves, give a jelly of too acid a flavour. They can, however, be used, if mixed in small quantities with the sweet and bitter sweets. The method of making the jelly, the kinds of apples required, and other uses of concentrated apple juice, are explained in a leaflet which can be obtained on application to the Agricultural and Horticultural Research Station, Long Ashton, Bristol, to which address any inquiries should be directed. It may be added that, although cider apples are not generally used for domestic cookery, they may be made quite suitable for this purpose by the addition of tartaric acid. Information on this point also can be obtained from the same quarter. This year the cider apple crop may not yield a surplus, but in cases where wastage is likely to occur, it can be obviated by using the fruit as indicated here.

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Destruction of Charlock; Experiments in Northamptonshire.

SUCCESSFUL experiments in the destruction of charlock have been carried out this year on two cornfields, part of the Northamptonshire County Council farm at Moulton, under the direction of Mr. W. A. Stewart, the Agricultural Organiser.

Both fields were sprayed with a four per cent. solution of copper sulphate—the first field on 18th May, before the flowers had formed, and the second field at the beginning of June, when numerous plants were in flower. The weather conditions during the spraying of the first field were for the most part dull and wet, while parts of the second field were sprayed under both wet and dry conditions.

The spraying was successful whether the charlock had flowered or not, and whether the operation was carried out in wet or dry weather. Spraying when the charlock was in flower was more effective than earlier spraying, and the drier the condition of the crop the more drastic was the effect of the copper sulphate on the

charlock. The corn itself was slightly more damaged in the later spraying and also under the drier conditions. In no case, however, was the corn crop permanently injured; such damage as occurred was only temporary.

It was further found that the more water used per acre (even without increasing the quantity of copper sulphate) the better the distribution and the more effective the results. On the first field, not only was the charlock practically eradicated as a result of spraying, but other weeds, notably thistles and coltsfoot, were affected, an exception being the corn sow thistle, which persisted. Hand pulling was tested on the second field, and, while successful, was found to be considerably more expensive than spraying with copper sulphate.

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Foot-and-Mouth Disease.

Norfolk.—No outbreak of the disease has occurred in the Emneth district since that referred to in last month's issue, p. 528, at Pentney, on the 18th August. In view of the favourable position, successive reductions in the extent of the area under restrictions were made as from the 3rd and 11th September, and eventually all remaining general Foot-and-Mouth Disease restrictions on movement, imposed by the Orders of the Ministry, in Norfolk were withdrawn as from the 21st September.

Sussex (East).—Foot-and-Mouth Disease was confirmed on premises near Uckfield on the 23rd August last, and it was accordingly necessary to impose restrictions on the movement of animals over the usual 15 miles area which embraced parts of Sussex, Kent and Surrey. There was one local extension of this outbreak on the 27th August. In view of the continued satisfactory position in the district since the latter date, it has been possible to withdraw all restrictions, except in respect of a small area of about 5 miles diameter surrounding the actual outbreaks.

Kent.—It has unfortunately again been necessary to impose restrictions over a wide area in Kent on account of the confirmation of Foot-and-Mouth Disease in that county, an outbreak having been confirmed on the 11th September on premises at Boughton, near Faversham. Fortunately, the premises were well isolated, and it is hoped that there will be no further spread of the disease in the district.

THE HISTORY OF A GRAIN OF WHEAT FROM THE SEED BED TO THE BREAKFAST TABLE.

SIR A. DANIEL HALL, K.C.B., F.R.S.,

Chief Scientific Adviser and Director-General of Intelligence Department, Ministry of Agriculture.

ON 24th August Sir Daniel Hall gave the concluding evening discourse at the Cardiff meeting of the British Association, and chose as his subject "The History of a Grain of Wheat from the Seed Bed to the Breakfast Table." He began by pointing out that there exist in the history of mankind no processes older, more essential or more universal than the growing, grinding and baking of wheat and its kindred food grains. It might seem, therefore, rather unnecessary, before a gathering for the advancement of science, to talk about a business which had been brought to something like perfection long before anything that could be called science had come into being. Countless years have elapsed since primitive man took the momentous step of sowing a little of the wild grain he had hitherto been content to gather, in the hope of saving himself some trouble in collecting the next year's crop. Millions of men have spent their lives in growing wheat, and, since the very life of the community has often depended upon a good wheat crop, all sorts of rewards have attended on its improvement. What possibly can there still be to learn about it? Yet at every stage in the passage of the grain of wheat from its seed bed to the breakfast table we find that we do not know all that we need to know in order to get on with the essential business of making two grains grow where one grew before.

Population overtaking Wheat Production.—The object of the lecture was to show that even in this fundamental industry science keeps coming in at every turn, and that research calling for the best of man's imagination, skill and determination is required if the world's progress is to continue. All biologists would agree that the development of man demands an abundant food supply, just as the gardener knows he cannot attain to fine flowers except upon a fat soil. But the population of the world is rapidly growing up to, if it has not for the moment exceeded, its available supply, and only by research and by the wide utilisation of the fruits of that research can we obtain the greater supply of food that the world needs. The most potent remedy for the

present discontents would be more wheat, and as the limits of potential wheat land have almost been reached the present problem is that of getting more wheat out of the land we possess.

Life of the Wheat Grain.—On examination the grain of wheat will be found to consist of a tiny embryo, the part which is alive, together with a much larger store of food called the endosperm, the function of which is to nourish the embryo until it can push a green leaf above the ground and begin to feed upon the air and the soil. Our food supply is the store which the plant accumulates to feed the embryo, for flour is nothing but the endosperm of the wheat berry in a powdered condition. As long as it is dry the embryo cannot draw upon the store in the endosperm. Since the embryo has to consume something in order to maintain its life it soon dies from exhaustion of its own substance, and with it the whole grain dies even though the endosperm is still unaltered. When stored some grains of wheat will die within a year, many more in two years, and very few will survive for such a period as 10 years. The idea that grains of wheat stored up with mummies in ancient tombs can be made to give a crop is a pure error.

Many experiments have been made in recent years in order to ascertain whether the seed cannot be excited by electricity or by steeping it in some nutrient fluid before it is sown, by which means it can be made to grow better and give a bigger crop. The results of these experiments, however, are very dubious. After all, the seed is only a means of starting the embryo into business. How well it will grow after the first week or two and what yield it will give depends upon the later development, which is determined by the soil, the available manure, the weather and other factors, quite apart from the seed. None of the exciting processes can add anything to the stock of energy contained in the seed and can therefore have little to say to its ultimate development, provided the seed is initially capable of starting at all.

Influence of Rate of Sowing Wheat on the Yield.—In the ordinary way in this country wheat is sown at the rate of about 2½ bushels to the acre, and the average yield is about 32 bushels, or a thirteenfold yield. Now an isolated wheat plant is capable of giving a hundredfold or even a thousandfold yield, and the question is often raised of whether we are not sowing an unnecessary amount of seed. If we examine the plants along the drill line in a wheat field we find that though there may be gaps there are a great number of spots where the seeds have come up too

thickly and are combating with one another to the detriment of the crop. Experiments are in hand for the improvement of the spacing of the wheat seed, and it is claimed that with a suitable machine a perfectly effective seeding can be attained with as little as a bushel to the acre. Even if we could reduce the amount of seed used by one bushed an acre the country would gain 3 per cent. on its output of wheat, worth well over £1,000,000 a year at the present time.

Varieties of Wheat.—Before sowing wheat it is necessary to settle what variety to grow, for hundreds of different sorts of wheat exist—some early, some late, some tall, some short in the straw, some close packed and others open in the ear. We know little about the original wild wheat or wheats, but nowadays varieties of the most diverse kinds in colour, shape, and size exist. In the ordinary way each of these sorts breeds perfectly true, because the flower of the wheat is self-fertilised. Here and there by a rare accident fertilisation does take place in the open field, and it is through these accidents that the multitude of varieties have come into being. As long as the wheat is normally self-fertilised selection can do little to improve it. If, for example, a farmer picks out from year to year the longest ears in the field or the plumpest berries in the sack and sows them he will not find that these characters persist in the next crop, which goes back to the old standard. Selection of this kind has been tried for fifty years in succession, and the wheat at the end could not be distinguished from samples of the first crop that had been preserved. In order to get new varieties there must be deliberate cross-breeding and selection among the progeny. This process was a very haphazard one until latterly, when Mendel showed the mechanism by which selection can be applied so as to pick out among the hybrids the desirable ones that will continue to breed true.

Working on Mendel's principle it is possible to combine in a new variety desirable points possessed by either of the parents: to combine, for example, a stiff straw in one parent with strong milling qualities possessed by the other parent. Professor Biffen, of Cambridge, has been working for many years on these lines. His first success was "Little Joss," a wheat with a wonderful cropping power on certain soils, because an extra power of resisting rust attacks had been introduced into it through its parentage. Afterwards Professor Biffen turned to the problem of combining the cropping powers of certain English wheats with the high milling quality of the wheats, for example, grown in Manitoba.

One of these wheats, "Yeoman," has given phenomenal crops on soils to which it is suited, and, while it is probably the heaviest cropping wheat generally grown, it yields flour almost up to the quality of the best Canadian. On many Eastern county farms the introduction of Professor Biffen's varieties has raised the average yield of wheat by at least 10 per cent. Many years of patient work are required before all parts of the country are provided with ideal varieties of wheat as regards their cropping power, the strength of their straw, their resistance to disease and the milling quality of their grain.

Wheat v. Weeds.—In spite of its vigour wheat when left to itself cannot stand up against the competition of weeds. At Rothamsted a wheat crop was once left unharvested to sow itself without further cultivation, and by three years the wheat had entirely disappeared in the grassy wilderness that had sprung up. But though wheat is thus dependent upon cultivation, no other plant possesses an equal capacity for producing a crop upon all sorts of soils, even upon the poorest. At Rothamsted upon one of the plots wheat has now been grown for 77 successive years without any manure, and it still yields about 12 bushels to the acre, which is approximately the avearge crop of all the wheat lands of the world. The adaptability of wheat is seen from the way it has become *the* crop for breaking in the wilderness. In the newer countries—South and North America or Australia—the settler upon virgin land always begins by taking a succession of wheat crops before he resorts to mixed farming. In the Argentine, for example, the wheat belt has crept across the country with each wave of settlement, being followed in very many cases by a sowing of lucerne (alfalfa) upon which the cattle are raised.

Manuring of Wheat and the Problem of Lodging.—By investigation, particularly by the Rothamsted experiments, it has long since been settled what manures are required for wheat. The chief trouble in this country is to get the wheat to stand up upon the richly manured land. In fact the main limitation at present upon the yield of wheat on the good soils is the liability of big crops to lodge. This problem of lodging affords a varied field of investigation, because so many factors have to be considered. On the one side we may attack it by breeding varieties with stiffer and shorter straw; on the other hand time of sowing, width of rows, and spacing of the seed requires consideration, together with methods of cultivation. More knowledge is required of the manures which will correct the tendency to go down, and there

is probably also an actual disease factor involved. On all these points experimental work is in progress.

Transfer of Food Material from the Plant to the Grain.—Experiments have shown that the wheat plant practically completes its growth, as far as gathering material from the air and from the soil is concerned, a month or five weeks before it is harvested. In this latter period the valuable material already accumulated by the plant is being moved from the stem and the leaves to the seed. This migration is very incomplete. The straw still retains half or more than half of the valuable material manufactured by the plant. Considering that the total material manufactured by the plant represents the limit of its capacity as a living organism and is determined by conditions outside our control, such as the soil and water supply, one line of improvement must clearly be to increase the migration into the seed and to ensure that the greatest proportion of the plant ends in the useful grain and not in the comparatively useless straw. Improvement in this direction is especially urgent in the drier countries where there is an absolute limitation of the amount of growth by the insufficient water supply.

Milling of Wheat.—Turning now to the flour, the object of the modern miller is not to grind wheat into a meal and then sift out the flour, but to crack the berry with the least amount of breaking up of the husk or bran, thus letting the endosperm fall out in a clean condition. The best white flour is practically pure endosperm in a powdered state. It is the most digestible part of the grain, and weight for weight yields the most food. Before the War only about 68 per cent. of the weight of the grain was recovered as white flour; the remainder passed into the various offals, which were chiefly used for pig feeding. Under the stress of war it was necessary also to bring into use the less digestible portions of the grain, and the extraction of flour from wheat was raised from 68 per cent. to over 90 per cent. Careful digestion experiments were made, and they showed that this higher extraction and addition of the less digestible portions of the wheat grain did increase the amount of real food by an amount which was equivalent to an extra two months' supply of wheat. The outer portions of the wheat berry that are rejected from white flour do also contain certain specially valuable food adjuncts, but, as many people learnt, are not suited to all constitutions.

Bread Making.—Flour made from the majority of English wheats without any admixture produces small dense loaves,

whereas certain Canadian and other wheats grown in similar climates give rise to big spongy loaves of the kind which the public prefer. In consequence, even the country miller is compelled to use a considerable admixture of strong wheats of overseas origin. In the course of the investigations that were set on foot by the Home Grown Wheat Committee, some 20 years ago now, one wheat was found which retained in the English climate this special property of giving a strong flour. This wheat grown in England is too poor a cropper to be profitable, but it has supplied to Professor Biffen the starting point for the combination of cropping power with strength, which characterises his "Yeoman" wheat. When well grown in the Eastern counties flour made from "Yeoman" wheat alone is as strong as the ordinary mixture made up by the miller for household flour. The limit of improvement in this direction has not yet been reached, and as new varieties containing this quality of strength are raised, the country miller may be rendered independent of foreign wheats.

Our Wheat Supplies.—Prior to the War we only grew one-fifth of the wheat we consumed. The rest came from North and South America, Russia, India and Australia. Some of these foreign supplies have been entirely cut off, and though America has responded to the call by increasing her wheat acreage during the War to an extent sufficient to feed Western Europe, the total wheat acreage in the world is still perilously short. There has been a general withdrawal of labour from the land, and with increasing prosperity many of the Oriental countries are increasing their consumption of wheat. For the next year we are safe enough, because a considerable "carry over" in North America coincides with an exportable surplus from India and Australia and a good crop in Argentina. But the permanent position is by no means assured, and unless more land is put under wheat a bad crop in one or two of the exporting countries, such as always comes at frequently recurring intervals, would create a serious scarcity of wheat in the whole world. As a national insurance it is a matter of the first necessity to grow more wheat at home. It is possible to extend our acreage; it is also possible to extend our production on the existing wheat land. In both cases, however, better skill and more knowledge are needed. The country, therefore, must not grudge expenditure upon the attainment of knowledge, because on knowledge hangs our assurance of a progressive food supply in the future.

PLANT BREEDING WORK AT ABERYSTWYTH.

PROFESSOR R. G. STAPLEDON, M.A.,
Plant Breeding Institution, Aberystwyth.

Introduction.—An increased output of home-grown food implies not only intensive farming but also the use of the best possible strains of plants and of the highest class of animals. The conditions in Wales, with its average high rainfall and not inconsiderable tracts of country under cultivation at altitudes of 600 to 800 ft. and with an appreciable acreage under the plough at elevations up to and occasionally over 1,300 ft., undoubtedly call for special strains of plants if crop production is to be maintained at a reasonably high level. It is satisfactory, therefore, to be able to state that owing to the foresight of Sir Laurence Philipps, Bart., of Llanstephan House, Boughrood, Radnorshire, who generously provided an endowment for the purpose, it has been possible to start a Plant Breeding Station with the avowed aim of improving and breeding strains of agricultural plants suitable for Welsh conditions.

The new Station is attached to the University College of Wales at Aberystwyth, and its work is, of course, closely associated with that of the Agricultural Department of the College. The activities of the Station commenced in May, 1919, with the appointment of a Director and a Research Assistant, who took up their duties immediately; a Kew-trained gardener joined the staff shortly afterwards. The Station has now been recognised by the Ministry of Agriculture as a Research Institution entitled to grants-in-aid from the Development Fund, and by virtue of substantial grants towards maintenance and salaries of fully qualified research workers it has been possible further to augment the scientific and outdoor staff for the current year's working.

Suitable laboratory accommodation has been arranged for in connection with the new Agricultural Buildings now nearing completion. Fortunately, the College was able to acquire for the Agricultural Department a disused foundry near the railway station at Aberystwyth. The work of alteration was taken in hand last summer, and the laboratories for the Department of Agricultural Botany and the Plant Breeding Station were in use as soon as last October, and are now

completely finished. The laboratories (see Plates I and II) are designed for each of three separate purposes:—

(1) A large laboratory primarily intended for students and capable of accommodating over 30 persons. The room is lit from both sides, two tiers of benches running from end to end on one side, and one bench on the other. A series of incubators for the purpose of seed testing occupy the body of the room; and the single bench, which is seldom required for classes, is used by laboratory assistants concerned with seed testing and other routine work in connection with the Plant Breeding Station. In the Easter and Summer Vacations the extensive benches in this laboratory are of considerable service both in preparing for the sowing of plots and in the handling of the harvests.

(2) Three special laboratories for the use of the staff of the Station. Two of these are arranged to give the maximum of bench and table space, and each is allocated to a branch of the work in hand. Both are equipped with special cabinets for filing seed samples, and with tiers of trays to facilitate the systematic handling of numerous samples while under investigation. The third is a small laboratory where the finer work, such as the preparation of microscopical slides, will be undertaken. The arrangement is based on the allocation of the laboratories to different aspects of the work rather than to individual investigators as such.

(3) Private laboratories have also been provided for (*a*) the Adviser in Agricultural Botany, and (*b*) the Lecturer in Agricultural Botany: the latter laboratory has been equipped for pathological work.

In addition to the laboratories a drying room and a gardener's workroom have been arranged for at the Agricultural Buildings. The design of the former is rendered apparent by reference to Plates III and IV. The room is 18 ft. high, the roof being reached by narrow passage ways; thus two tiers of hanging pegs are available. Racks are arranged around the sides of the room on the floor level: they are used for the dual purpose of making hay off small plots or from individual plants, and for drying heads of seed on shallow trays.

It was decided that the drying room should be at the laboratories rather than at the garden, so that use could be made of the central heating, and also because the room is only intended to deal with small "lots" which would in

most cases in any event, sooner or later, have to come to the laboratories. A room of this kind was considered essential, owing to the uncertainty of the seasons in the West, and it has proved of great value during the present wet summer.

The gardener's room is designed for dealing with the threshing and cleaning of small and special "lots" of seed such as in many years may be "made" or partially "made" in the drying room. Special tackle run off a ¾ h.p. electric motor is being used for this purpose. The label writing, preparation of pollen-proof capsules, and such like work, will also be undertaken in this room.

The College Authorities were able to place about 4 acres of garden ground at the disposal of the Station at its inception. This ground was broken and turned into allotments during the War, and has since been converted into very satisfactory gardens. It has the great advantage of being within about 15 minutes' walk of the laboratories. In addition a 13-acre arable field within easy reach of the gardens was taken in hand for larger trials. A farm of 92 acres has now also been acquired for the sole use of the Plant Breeding Station. The farm practically adjoins the experimental field referred to above, and will be available for the work of the current session.

The preliminary arrangements necessary before exhaustive investigations could be proceeded with have thus been completed within eighteen months of the foundation of the Station.

Before entering into details as to the manner in which the gardens have been laid out it is desirable to review briefly the work already in hand, and to indicate the lines upon which it is proposed to develop the activities of the Station.

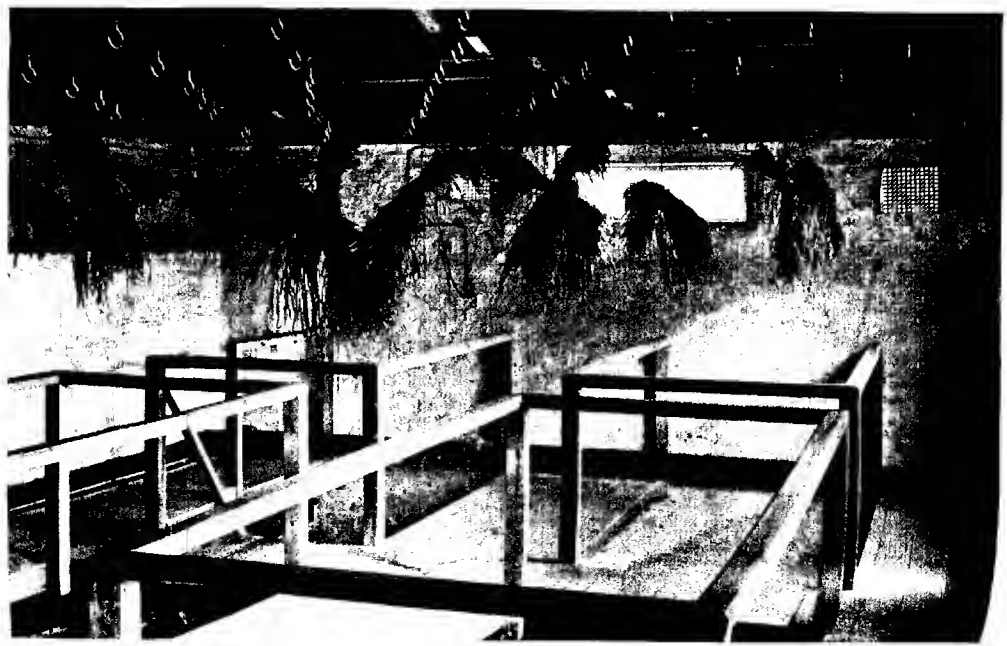
Herbage Plants.—A characteristic feature of the agriculture of Wales and the West of England is grassland: not only permanent, but also temporary grass.

Leys of 4 to 6 years' duration are commonly employed in the rotation. It was decided, therefore, to devote very considerable attention to the problems connected with the improvement of herbage plants, the more so since this is an aspect of economic plant breeding which has not been exhaustively investigated in this country.

In dealing with grasses and clovers numerous difficulties immediately present themselves. It is essential, for instance, to be able to study single plants, and with grasses sown in drills or broadcasted it is not easy to separate out individual

PLATE I.—Showing the Seed Testing Incubators in the large Laboratory. Closed Hearson Incubators are behind and Copenhagen Tanks in front.

PLATE III.—Showing the arrangement of the floor section of the Drying Room. Hay is being made of samples of Cocksfoot on the racks: pegs for hanging samples are shown on the upper passage ways and seed bins against the wall.



plants. The method of sowing in boxes and subsequently planting out employed in Denmark has therefore been adopted. The box culture section in the main garden is shown in Plate V. This consists of brick-sided trenches 12½ in. deep, and 3 ft. 7 in. broad. Strong boxes of a convenient size for lifting are used; when watering becomes necessary the trenches are flooded in sections. The trenches are placed in a large mesh cage sufficient to keep out wood pigeons (which are a particular nuisance in the district) and other large birds. Special "lots" are started in this manner, both for garden and small-scale field trials, the plants being put out in spaced rows with ample room between them.

A further difficulty has to be contended with in the form of "volunteers" of the species under investigation. There is the danger that such seed may be in the soil and so contaminate the seedlings, and it is essential, when dealing with pedigree cultures, that this undesirable seed should be killed. Arrangements are being made to provide a suitable plant to heat sufficiently the soil used for the boxes so as to kill "volunteer" seeds before sowing; in the meantime a useful method applicable to such small lots of seed as those from a single head of a grass or a clover has been under investigation during the past season. The method consists of starting the seed on an incubator in a greenhouse, and pricking off the germinated seeds and planting in boxes in spaced rows. It has been found that with careful handling the minute seedlings transplant quite satisfactorily. This plan affords the additional advantage of safeguarding germination and providing a germination test.

Work on herbage plants, the great majority of which are cross fertilized, demands special precautions and methods with a view to regulating pollination. The question of pollen-proof cages and capsules is exceedingly important and especially difficult when working in a wet climate, and investigations are being made as a preliminary to the more serious study of the fertilization affinities of the commoner grasses and clovers.* It was early apparent that all pollination work and studies would have to be conducted under grave disadvantages, not only on account of the common occurrence of wet weather during May, June and July, but also because of the strong winds and gales which are a feature of the prevailing climatic

* It will be necessary to ascertain whether under the climatic conditions prevailing in Wales the findings of Continental and American workers apply to the grasses and clovers under investigation.

conditions. It was decided, therefore, to resort to glass as an assistance. A large span house with cage and trolleys has now been erected to facilitate this aspect of the work. The house (unfinished) is shown in Plate VI. This illustration also shows the large cage, the bottom part of which contains the box culture trenches; the upper part is small mesh, and is used for cereal work. Experimental pollen-proof cages are also shown, and to the left, on the grass bed, are pollen-proof capsules covering panicles of cocksfoot.

The herbage plant work aims not only at improving the common grasses and clovers already in agricultural use in Wales but also at introducing herbage plants which are not at present used, or if so only very slightly, in this country and at examining the possible usefulness of some of these plants as parents for hybridization.

With a view to this latter end small scale trials are first set out in the garden, and followed up on a larger scale with plants which show any promise. An interesting trial embracing about thirty species was sown down during the spring.* The course adopted is to sow half of each bed in drills *in situ* and to make up the remainder of the bed with spaced single plants obtained from the boxes. It is naturally to be expected that the great majority of the species tested will prove to be quite useless; and it is interesting to record, therefore, that a few species in particular have shown to sufficient advantage to merit further investigation and trial. These species are (1) a variety of *Trifolium subterraneum*† which makes unusually robust and rapid growth, (2) *Phalaris nodosa*, (3) *Danthonia pilosa*, (4) Teff grass (*Eragrostis abyssinica*), and (5) Hairy Vetch (*Vicia villosa*).

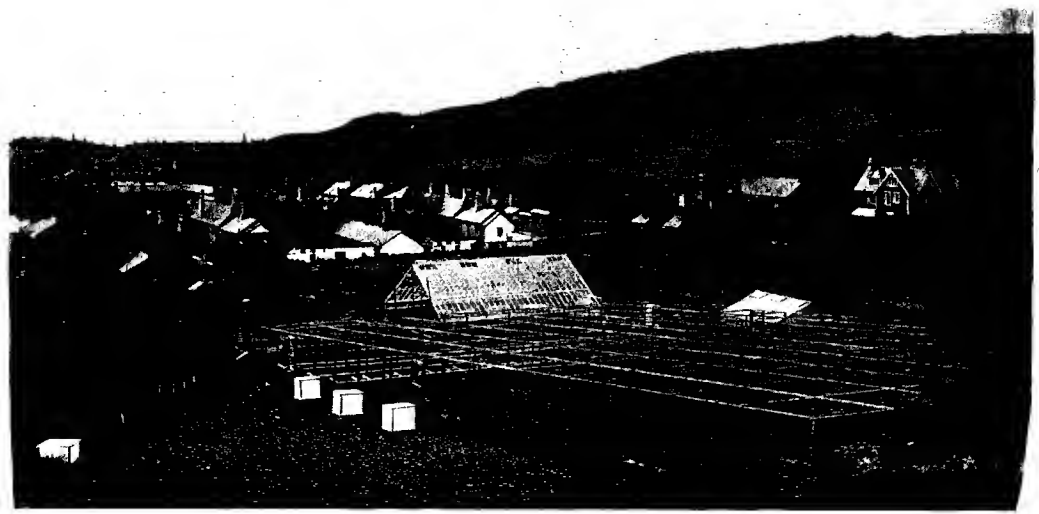
(1) *Trifolium subterraneum*.—This is certainly a remarkable plant. In the garden it produced a dense growth, and within ten weeks of sowing, rows 15 in. apart were completely filled up, some of the runners being over 18 in. long. Sown on 29th April, 1920, it flowered to some extent in August; sown on 30th June, 1919, it did not flower in the autumn, but

*Thanks are due to Dr. Taylor, Chief of the Bureau of Plant Industry, U.S.A., and to Messrs. Donaldson, of Edinburgh, who obtained a considerable number of special seeds for the Station. Other varieties were obtained from Messrs. Vilmorin Andrieux et Cie., of Paris, and Messrs. Haage and Schmidt, of Erfurt.

† The seed was obtained through Messrs. Donaldson, who stated that it is used in Australia. Further and exact information is being sought, but has not yet been obtained.

The seed would seem to be expensive (15s. per lb.); if the plant ultimately proves to be of value the preliminary trials conducted suggest that seed production may possibly be quite feasible in this country.

PLATE V.—Showing the Box Culture Section in the garden. Note the arrangement of the boxes in the trenches: this allows of easy handling.



maintained growth more or less all through the winter and produced more winter foliage than did the red clovers. It flowered and set seed the following spring. The plant is being further tested in rod plots sown at various rates alone and in competition with red clover and with ryegrass and cocksfoot. The evidence so far obtained suggests that the plant may be particularly valuable for providing an autumn bite on stubbles, as when sown under corn it does not make tall growth.

(2) *Phalaris nodosa*.—This plant was sown in April, and had made luxuriant growth by August, the foliage being abundant and the leaves broad. The grass is grown in South Africa, and according to Bews it gives rich pasturage, being both hardy and frost resisting.*

(3) *Danthonia pilosa*.—Seed sown at the end of April produced good plants in August, when one or two sent up flowering heads. The foliage is dark green, forming dense little clusters, and the leaves are rather thick and narrow. The seeds of this grass would seem to be successfully employed in mixtures in New Zealand.

(4) Teff Grass (*Eragrostis abyssinica*).—This was tried in 1919, and again this spring. It was thought that it might be useful as a late spring-sown catch crop. In 1919 it was sown on 3rd July, and had made quite good growth by the end of August, but was browned by the first slight frost; sown in June and again in July, 1920, under the wet conditions obtaining, the plants never started into growth, the contrast between the two seasons being very noteworthy. This is thus a plant which may possibly repay further trial in the east and south of England, but is obviously of no value in Wales. Bews states that this annual grass is successfully grown for hay in the High Veld areas of Natal and the Transvaal.

(5) Hairy Vetch (*Vicia villosa*).—This plant, when sown in garden trials, showed itself capable of producing a considerably heavier crop than the common vetch. As Lawson† states, it comes away slowly at first, but when fully grown produces a very heavy crop. The seed is at present much more expensive than is that of common vetch, but if seed could be grown at all economically in this country the plant should be again extensively tried.‡ Field scale trials are being arranged this autumn, since it would appear that

* Bews, J. W., "The Grasses and Grasslands of South Africa."

† "Vegetable Products of Scotland."

‡ Piper ("Forage Plants and their Culture") states that Hairy Vetch was cultivated in England in 1815 and in Scotland in 1833, and that it is now (1917) becoming more and more appreciated in America.

spring sowing hardly gives the plant a sufficiently long growing season.

Of the plants that have given convincingly negative results, the following may be mentioned:—Berseem (*Trifolium alexandrinum*), which did not come into flower, and produced much less than Crimson Clover; Sulla (*Hedysarum coronarium*), which only grew sufficiently to produce a few pinnatifid leaves. Chick Pea (*Cicer arietinum*), which made very slight growth and did not come into flower. Rhodes Grass (*Chloris gayana*, a native of South Africa, a grass which has received considerable attention in Australia; Sudan Grass (*Andropogon sorghum var*); and Johnson Grass (*Andropogon halepensis*), all made negligible growth.

With regard to the improvement of existing strains of the grasses and clovers in common use, it appeared necessary, as a preliminary, to conduct exhaustive nationality and place-of-origin trials with the commercial seed at present available, with a view to making a critical study of the characteristics of the plants, and also in order to ascertain the possibility of selection from the best commercial strains and eventually to be in a position to institute comparisons between the Station's selections and the most successful nationalities of imported seeds. Both field and garden plots have been formed. In 1919 about 266 small garden trials, dealing with red clover, cocksfoot and ryegrass were sown; this spring a further 250 garden plots were arranged; tall oat grass, rough stalked meadow grass, meadow fescue and white clover were also included, and in addition 310 rod plots* have been laid out in the field.

It is premature to discuss the results so far obtained, and final conclusions cannot be drawn until the trials have been repeated and conducted for a number of years, especially as the chief aim of the investigations with herbage plants is to obtain strains of uniform productiveness for 4- to 6-year periods.

In the matter of red clovers, however, it is of interest that the late flowering reds, certain strains of Montgomery red clover, and Cornish marl grass clover, have given on the average the best results in the first year. Cornish marl grass clover appears to be decidedly distinctive, and has the reputation of being a truly perennial plant.† Of the foreign clovers the most

* Rod plots are always sown on the basis of a uniform and appropriate number of germinable seeds to the acre.

† This clover is grown for seed in a restricted area near Wadebridge, and would not seem to be at all generally used except quite locally.

PLATE VII.—Showing stems of Red Clover attacked by a *Gloeosporium* disease. Note that the stems are almost completely girdled by diseased tissue, and several of the petioles are broken.

noteworthy fact has been the very poor results obtained from Italian seed, due chiefly perhaps to the incidence of a disease (due to fungus *Gloeosporium* sp.). This disease was first noticed on the Italian beds, and the greatest damage was caused to the clovers from this source.

The disease in question is under further investigation. The following brief notes are supplied by Miss K. Sampson, M.Sc., who has kept records of the incidence of disease on the various plots:—

The *Gloeosporium* disease of red clover is recognised by the characteristic discoloured areas on the leaf-stalks and flowering stems. They may be $\frac{1}{4}$ to $1\frac{1}{2}$ in. long, and nearly girdle the stem or petiole. The margin of each diseased area is black, and the centre is brown and dry or contains a central cavity extending to the hollow of the stem. As the stem is often completely girdled by diseased tissue and breaks at the diseased patch, dead and shrivelled leaves and stems are a conspicuous feature of a clover bed attacked by this disease. (See Plate VII.)

The fungus *Gloeosporium* sp. is spread by microscopic spores produced in minute colourless pustules which can be seen when the diseased areas on stems and petioles are examined under a strong lens. Every diseased patch is thus a centre from which the fungus may spread to new leaves and stems. It is significant of the serious extent to which the disease may spread that two beds of red clover from Italian seed examined in July, when neighbouring beds were in full flower, showed only one flowering stem in each bed, all others having been destroyed by the attacks of this fungus.

The *Gloeosporium* disease was first noticed on the red clover plots at the end of April, 1920, and observations were made during May, June and July. Although the disease was widely distributed among the beds there was a marked difference in the extent of the damage suffered by clovers of different origin. As has been indicated above, the beds from Italian seed were most severely attacked, and in two instances practically destroyed. By the middle of July serious damage had been done on beds of English, Brittany, Canadian and Wisconsin clover, and the attack was only slightly less severe on beds of Chilian red clover. The most striking feature arising out of the observations was the relative freedom from disease of late flowering red. Throughout the season this variety presented, in the green healthy appearance of the

foliage, a marked contrast to all other varieties, with the exception of Cornish marl, which, although somewhat different from late flowering, is none the less late to flower. A similar disease of red clover, due to the fungus *Gloeosporium caulivorum*, is known on the Continent and in America, where it has frequently been the cause of serious damage to the clover crop.

The small scale nationality trials have proved interesting in several other directions.

It has been noted that tall oat grass grown alone gives very large first hay crops. The following comparative figures show the average yields of hay from small pure plots cut on 1st June. The percentage of leaf of the hay is also shown:—

	Comparative Hay Yields.	Percentage of Leaf in the Hay.
Timothy	100	43·5
Tall Oat Grass	96	42·0
Perennial Ryegrass	92	18·0
Italian Ryegrass	80	24·0
Cocksfoot (Commercial)	63	19·0
Meadow Fescue	49	46·0

It will be noticed that perennial ryegrass cut heavier than Italian; this is doubtless due in part to the fact that Italian ryegrass matures somewhat later than perennial, but the chief difference is probably owing to the excessive relative "stemminess" of perennial. It was noteworthy that Italian ryegrass stood much better than did perennial, isolated Italian plants remaining standing in perennial beds when the whole of the perennial had gone down. Cocksfoot also stands well: tall oat grass and Timothy are moderate in this respect; while late flowering red clover goes down very much worse than broad red, probably because the plant is taller and produces more numerous lateral branches, especially towards the upper third of the stem.

It is well known that Westernwolth's Italian ryegrass makes more rapid growth than does ordinary Italian. This fact was amply confirmed by the trials at the Station. A number of Italian strains of which the seeds were supplied by the Ministry of Agriculture were included in the trials. It was noticed that the Italian vetches (*Vicia sativa*) produced in twelve weeks very appreciably less growth than did vetches harvested in Essex; that the lucerne showed poorly in comparison with seed from Provence; and that the sainfoin did

not compare favourably with plots sown with Gloucestershire seed.*

The foregoing account refers to investigations which are regarded as necessary preliminaries to the actual breeding work with herbage plants. The plan adopted with reference to breeding grasses and clovers follows closely that at present employed at Svalöf and in Denmark, and aims at selecting from promising indigenous plants. It is interesting to note that this procedure has in the past actually been put into practice in this country, and with apparently good results. For some unaccountable reason, however, it has never been followed up and made the subject of long continued and exhaustive scientific inquiry, and no proper precautions have been taken to maintain the purity of such strains as have been selected. Thus Peter Lawson and Son, writing in 1852,† refer to and give particulars of no less than twelve leading "sorts" of perennial ryegrass, but to-day samples offered under well-known names such as "Devonshire Evers" and "Pacey's" seldom appear to have any very distinctive characteristics, the name, but not the strain, as such, having been handed down to the present generation of farmers.

Two methods are now being employed at Aberystwyth, namely, the collection of seed and the digging up of plants *in toto* and bringing them to and planting them in the gardens.

As a first step the seed of indigenous grasses was collected more or less in bulk from several different districts.‡ The object was merely to ascertain whether indigenous seed (without special selection) compared favourably or the reverse with the ordinary commercial and imported stocks. Cocksfoot, tall oat grass, crested dog's tail, meadow foxtail and Timothy were in the first instance collected and sown, and perennial ryegrass, tall fescue and rough stalked meadow grass have since been added to the species thus brought under preliminary investigation.

(To be concluded next month.)

* It must be pointed out that neither lucerne or sainfoin have grown in the district, and it is possible that the Italian lucerne and sainfoin plants may prove to be relatively hardy and lasting.

† Ibid.

‡ This work was commenced under the auspices of the Technical Division of the Food Production Department during the summer of 1918. The Station therefore owes it to the Ministry that a considerable amount of seed was available and made over to the Station for sowing in the gardens in 1919. Thanks are due to Dr. Brenchley, Mr. Fryer, Mr. Jenkin, Miss Sampson, Mr. H. H. Dunn and others who helped in the original collection of seed for the Food Production Department.

THE BRITISH DAIRY FARMERS' ASSOCIATION.

F. J. LLOYD, F.C.S., F.I.C.,

Consulting Chemist and Dairy Bacteriologist, British Dairy Farmers' Association.

IT is not generally realised what was the condition of the milk supply of London as recently as 70 years ago, when nearly all the milk then consumed was produced by cows in London and its suburbs. Mr. E. C. Tisdall, an original and active member of the British Dairy Farmers' Association up to the time of his death, had himself milked the cows at Kensington Park Farm in the fields where the Albert Hall now stands.

The idea of bringing milk into London by rail appears to have come first to Sir (then Mr.) George Barham about 1860. By the year 1864 he had established the "Express Country Milk Co.," and when the outbreak of cattle plague in 1865 threatened a milk famine in London, it was largely through Mr. Barham's undertaking and his remarkable energy that such a disaster was prevented.

London, however, was growing rapidly, the demand for milk was increasing, and the difficulty and danger of producing it in town sheds were becoming more and more pronounced. Town and country were thus for once brought together in a common interest; for it must be remembered that no small number of the London dairymen at this period were essentially dairy farmers, possessing all the practical experience of their calling and also those business methods and habits which life in the metropolis engenders. It was to this rare combination in many of its original workers that the future success of the Association was due.

The feeling arose that those engaged in the dairy industry should associate more than had been possible in the past. After two years of agitation in the press, a meeting was held on 24th October, 1876, at a Metropolitan Dairy Show inaugurated by the Agricultural Hall Auction Co., Islington. At this meeting Professor (then Mr.) Sheldon read a paper to open a discussion on the desirability of forming such an association, and proposed that one should be formed, with the title "The British Dairy Farmers' Association." The resolution was carried unanimously, and a Committee was appointed to act on the terms of the resolution.

Objects of the Association.—The objects for which the Association was formed were summarised by the Chairman, Mr. John Coleman, at this meeting. He said that there was much to be discovered, and much knowledge to be spread abroad in connection with dairy matters, and that the best means of advancing the cause of dairy farmers, and enabling them the better to meet the demands made upon them by the public, was to establish an association which should bind them together for the mutual improvement of their industry. This was further enforced in the first issue of the *Journal* published by the newly-formed body in 1877, in the words: "It must be borne in mind that the Association exists for the improvement of dairy husbandry in Great Britain."

It is necessary to emphasise this fact, for many people seem to think that the Association was formed merely to hold a Dairy Show. This may partly explain why the Association has never been sufficiently supported by the dairy farmers of this country, nor its influence and true scope fully appreciated by the British Government during the 45 years of its existence.

Initial Work.—We may best judge of the intention of the promoters by studying their first efforts. Mr. J. P. Sheldon was asked and agreed to visit the Hamburg Dairy Show in March, 1877, with a view to writing a report on his visit. This report was published the same year in Part I of the first Journal of the Association.

The Government was early approached on the question of cattle disease, and research work was undertaken (*see* p. 644).

The Association decided to offer medals at the London, Frome and Kilmarnock Dairy Shows for the best cows for dairy purposes, the best exhibits of cheese and butter, and implements of merit for dairy purposes.

The subject of dairy education also received attention, and details were obtained of a Dairy Station formed in Bavaria with the object of assisting the dairy industry in that State. This action marks a step in the promotion of the dairy interests in this country by the encouragement of scientific and practical education in subjects related to the dairy industry.

That the primary objects of the Association should have been educational, using the word in its widest sense, is not to be wondered at when we study the names of the original founders. Foremost among them was the late Dr. Augustus Voelcker, whose scientific knowledge, wide acquaintance with practice and keen sympathy with farmers, enabled him to see the great need for

improved education and a proper training for those who contemplated taking up any branch of the dairy industry.

The desirability of holding a National Dairy Show had occurred to some of the original promoters, but it was not until 1878, two years after the formation of the Association, that the Committee held its first Dairy Show.

On 1st October, 1879, the Association was incorporated, and the Committee was then replaced by a Council. The members gradually increased, and at the end of 1879 the number was 360.

The influence exerted by a Society generally depends in large measure upon the impressions which the ideas of a few members make upon the body as a whole, and, as a corporate body, of being able to further these ideas more widely and more rapidly than could an individual. The Association has been fortunate in this way. Among the pioneers, Mr. E. C. Tisdall was destined to play a leading part, especially in the improvement of dairy cattle. The necessity for such improvement had long attracted his attention, and in a paper contributed to the second part of the first Journal he impressed upon dairy farmers that they should "breed a race of cows more consonant with their own interest and the requirements of the community."

These views were enforced by careful records of the daily yield of milk from each cow in a herd of 60. Such records, probably the first of their kind, attracted considerable interest, and in 1881 Mr. T. Higgin, of Liverpool, offered a challenge cup for the best dairy farm record, which was competed for in the following year. Since that time the Association has continued to impress upon dairy farmers the importance of records.

Simultaneously Professor Sheldon, by active propaganda work, was aiming at the improvement of methods of dairy farming. The results of his efforts were important, and the work has been continued by the Association.

Milking Trials.—At the first three dairy shows, the prizes appear to have been given to cows merely after inspection of the animals. In 1879 and 1880 milking trials were instituted, and a report on the results obtained was published. The trials have been continued ever since, modified or extended as experience dictated, and have thrown light upon many problems. They have shown the natural fluctuations in milk, the peculiarities of breeds and individuals, and the possibilities of improvement.

Conferences.—In 1885 it was decided to extend the educational work of the Association by holding Conferences in the

country to discuss matters of importance to dairy farmers. These Conferences have since been a regular feature of the work of the Association. People engaged in dairying have been brought together and enabled to discuss matters affecting their industry to their mutual interest. The practical and scientific man has had the opportunity of exchanging views, each learning from the other the directions in which possibilities of improvement might lie. The Conferences have not been confined to this country, but have been held in many parts of the Continent, thus enhancing their educational value and making them more than national in scope.

It is difficult to estimate the value of the Conferences. The pleasure of social intercourse, the excitement of new scenes and the sense of a holiday which absence from home and the daily task gives to each of us, has caused some people to regard them as pleasure trips. Their real value, however, has been educational, affecting not only individuals attending, but also, through printed reports, far greater numbers who were unable to attend. The Conferences, in fact, have had an important beneficial effect, of international magnitude, upon the dairy industry.

Education.—While the leaders were striving to improve the dairy industry, there were few signs that the rising generation were studying the progress which had been made. To encourage a proper study of dairy science and practice, the Association in 1887 offered to award a Diploma to each successful candidate, and an examination was held for this purpose. The results were not satisfactory, and in the following year a Dairy Institute for the instruction of pupils was opened near Aylesbury, Mr. John Benson being appointed Manager and Instructor.

Much of the progress of the last thirty years may be traced to these examinations and to the instruction given in dairying. The Institute became a centre which attracted the best ability and from which for many years the leading teachers in this country were sent out. Many of these themselves became trainers of new workers.

It was the presence of these numerous skilled workers in the dairy industry during the War which largely enabled the industry at home to survive the numerous and drastic changes which were imposed upon it.

No review of the educational work of the Association would be complete without reference to the invaluable service rendered by Dr. Augustus Voelcker. From the beginning of the Association's activities he urged the importance of the application of

science to the dairying industry, and his results in this direction have been considerable in developing the industry on the right lines.

Research.—The first efforts in dairy research undertaken by the Association were a series of experiments on the feeding of dairy cows, carried out on Lord Vernon's dairy herd in 1886. Three lots of cows, as nearly similar in all respects as possible, were selected, and it was found that the lot receiving 21 lb. per head per day of properly proportioned dry matter gave as good results as other cattle receiving respectively 29 lb. and 34 lb. per head per day. The experiments thus proved that the system of feeding then in vogue was costly and wasteful, and that an excess of food over and above what the animals can assimilate is wasted. Their influence was very great at the time, and has affected the feeding of dairy stock in this country ever since.

Some of the most valuable research work carried out by the Association has been in the domain of veterinary and bacteriological science. The diseases of cattle had, as already mentioned, attracted the attention of the original founders of the Association. Abortion was of widespread prevalence in 1879-80, and Professor J. Wortley Axe, of the Royal Veterinary College, investigated the matter at the request of the Association. In 1887 it was assumed that scarlatina was produced by milk from Hendon owing to an eruption on the teats of cows. An outbreak of diphtheria occurred at Framley, and was also attributed to milk. Into these and other outbreaks Professor Axe made, on behalf of the Association, careful and elaborate investigations. That the scarlatina came from cows was disproved, while the source of the diphtheria was traced to contaminated water with which the milk vessels were washed, and thus the disease conveyed from man to man.

Tuberculosis in cattle and its possible relation to the same disease in man, has been from 1887 a subject of growing importance. The view of the medical profession was that this disease was probably due to milk. This raised the question as to the prevalence of this disease in cows and of the bacilli in milk. Professor Axe made a careful investigation into the matter, and his results were published in the Association's Journal for 1899 (Vol. 14). They showed that the prevalence of tuberculosis in cows, and especially of the bacilli in milk, had been greatly exaggerated.

The medical profession also asserted that milk frequently contained pus, and was not fit for human consumption. The Associa-

tion had the matter thoroughly investigated, and a report on the results of the investigations was published in its Journal for 1910 and 1911. It was conclusively proved that what had been taken by superficial observers to be pus cells were normal cellular structures of healthy milk.

Work During the War.—After the outbreak of the War the work of the Association naturally declined. A show was held in 1915, but thereafter the shows fell into abeyance until 1919. At a public meeting of dairy farmers held at Westminster on 6th February, 1918, under the presidency of Lord Desborough, K.C.V.O., the following resolutions were passed unanimously:—

"1. It is desirable to discourage the slaughter of every healthy cow and female calf adapted for dairy purposes so as to ensure the utmost possible production of milk now and in the future.

"2. Cheese is the most perfect substitute for meat, hence all milk that can possibly be spared should be converted into cheese; and as the whey from cheese-making is best utilised when fed to pigs, the maximum number of pigs should be so fed, and to attain this end a necessary supply of offal, particularly from home-grown cereals, should be ensured."

Had the policy indicated in these resolutions been adopted from the very commencement of hostilities this country would not now be so heavily in debt to others.

Such, in brief, are the foundations upon which the dairy industry of this country has been built up since the inception of the British Dairy Farmers' Association. It has been a natural process of evolution, and during the period vast changes have taken place.

From the commencement of its activities the Association has been impressing upon dairy farmers the necessity of improving dairy stock, of increasing milk production, of economy in feeding, and of skill in the manufacture of all dairy products. The War emphasised the need of attention to these matters.

By its thirty years' educational work the Association has taught those engaged in the industry how to obtain results far beyond what were previously thought possible; it has sent authorities on dairying to all our colonies, and has helped to promote dairy education throughout the British Empire.

The great help which the Association gave the country during the terrible years of War was not direct, but indirect. It had trained an army of skilled workers, many of whom were found

invaluable during the emergency in teaching, organising, and directing various branches of the Government's work. Owing to its activities, also, the country possessed many skilled dairy farmers who proved capable of carrying on under the most trying and often irritating conditions ever imposed upon an industry.

In production of milk for consumption there has been a constant endeavour to ensure quantity, quality and cleanliness. The methods of making butter and cheese have been completely revolutionised by scientific progress. There is still room for improvement, and great changes loom in the distance. Science must lead, practice will follow.

BREEDING DAIRY CATTLE FOR MILK PRODUCTION.

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DURING recent years attention has been repeatedly directed to the importance of increasing the yield of milk from the dairy herds of this country. The Committee on the Production and Distribution of Milk, in their Final Report,* draw attention to the steps which can be taken to reduce the cost of production and increase the profit to the farmer, and the Agricultural Sub-Committee, in dealing with the subject of the improvement of home breeds,† laid special stress on the possibility of obtaining better yields by improved breeding methods.

In order that a farmer may discover and dispose of his poorest and unprofitable milkers, it is essential that the practice of milk recording should be adopted, while a careful study of methods of feeding may result in a better yield from the same expenditure on food, but to maintain a herd at a high average yield it is necessary to ensure that the heifers reared to replenish the herd shall milk as well as, or better than, their dams. To attain this result, the utmost care must be given to the selection of the sire and to the choice of cows which are likely to produce heifers of the desired type and qualities.

The owner who wishes to improve his herd by breeding must first decide upon the type of animal he wishes to breed. Where the herd consists of cows of purely dairy type, such as Jerseys, Guernseys, or Ayrshires, the decision should not be difficult, but attention will need to be given to differences in type and size. Thus, in Jerseys the rent-paying farmer may well consider whether he should adhere to the Island type or try to develop a larger, hardier type, it may be less refined, but possessing equal or greater powers of milk production.

With cows of the dual-purpose type, the need for a clearly defined aim is even more necessary. As the objects for which the dual-purpose cow is kept are to give a good yield of milk annually (say 7,000 lb. to 10,000 lb), to lay on flesh readily on the best parts of the carcass when fattening, and to produce

* Final Report of the Committee on the Production and Distribution of Milk. Cmd. 428), p. 13, par. 51 (2); p. 14, par. 59.
† Ibid, p. 29, par. 3.

heifer calves which will be satisfactory dairy cows and bull calves which can be reared into good steers, it is easy for the breeder to think so much of one of these objects as to neglect others.

There is considerable divergence of opinion as to whether the dual-purpose ideal is really attainable, *i.e.*, whether it is possible to combine in a family of animals the desired excellence in all directions. It is readily granted that individual cows possess the two qualities of large milk yield and fattening capacity to a high degree, but it is by no means proved that they possess the power of producing both heifers as good as themselves, and steers with the conformation and fattening capacity required in high-class beef animals. The practice of some breeders in selecting one bull from a family more noted for beef than for milk in order to increase the substance of the herd, and, later, selecting a bull from a dam with a high milk record in order to raise the falling milk yield, supports to some extent the point of view that it is almost impossible to breed dual-purpose cows from similar stock with any certainty.

It is sufficient here to point out that efforts to attain a dual-purpose ideal may lessen the chances of success in breeding for milk production, and it is suggested that the farmer whose main source of income is milk or other dairy products, should concentrate his attention on improving the constitution, the breeding powers and the milk yield of his herd.

The breeder should first make himself familiar with the principles of breeding, and consider their application to his own particular conditions. More rapid progress is likely to be made when a group of farmers in one district are working for improvement in the same direction and with similar material. Friendly co-operation and competition are invaluable, and in this direction Milk Recording Societies may do much in bringing owners of the same breeds or with the same aims in touch with one another.

Principles and Systems of Breeding.—The first principle to be noted is embodied in the familiar phrase "like begets like," and the second is that the progeny always show a greater or lesser degree of variation from their parents. A tendency has become evident in recent years to modify the first phrase to "like tends to beget like," and to amplify it to "like begets like or the likeness of an ancestor." Observation suggests that the latter is probably more correct. It has been the custom of some writers on breeding to speak of the inheritance by the immediate

progeny of characteristics possessed by their parents and the variation of progeny from the characteristics of their parents as antagonistic "forces," but a closer study of the problem has made it clear that, except in very rare cases, variations from the type, colour, &c., of the parents may be just as truly inherited from some ancestor as are the exact repetitions of features possessed by the parents. Further, variations may be either away from or toward the ideal aimed at. The former are undesirable and disappointing, while the latter constitute an opportunity for progress in the desired direction. The main problem for breeders is how to transmit the maximum inheritance of the desirable qualities possessed by the parents. The *uncertainty* as to the results which will follow from the mating of any two animals is one of the greatest hindrances to successful breeding.

The application to stock breeding of the discoveries of Mendel and his followers has thrown considerable light on the inheritance of such easily identified characteristics as colour of coat, colour of face, and presence or absence of horns, but little progress has as yet been made with other and more important characteristics, such as high and low milk yield, high and low butter fat content, capacity for fattening and tendency to leanness. Progress has been hindered by the absence of clean-cut dividing lines and the difficulties of identification, the slow rate of reproduction in cattle, the differentiation of sex and the impossibility of directly assessing the dairy qualities of bulls. These difficulties, however, should be overcome in time, and there are doubtless many present-day breeders who would be ready to co-operate in the collection of data on single or related points if some lead were given them in this direction. Mendelism may one day enable the dairy farmer to breed heavy-milking stock with the same certainty as the breeder of Aberdeen Angus cattle breeds black and hornless animals.

Systems of Breeding.—The systems of breeding adopted are usually described by one or other of the terms crossing, grading, in-breeding, or line-breeding.

Crossing usually describes the mating of animals of distinct breeds, *e.g.*, Shorthorn with Jersey. The first cross between some breeds is often a popular and useful commercial animal, combining to some extent the desirable characteristics of the parents. At the same time, the introduction of the characteristics of another breed must increase the uncertainty as to the qualities which will appear in individual offspring, particularly in the second generation. Crossing, therefore, by

increasing the tendency to and possibility of variation, cannot be a successful means of improving a herd. Crossing is sometimes applied to the mating of animals of different types or families within a breed, and the result in this case is similar; the first cross often shows a combination of the qualities of the parents, but in later progeny the greater tendency to variation increases the uncertainty as to the inherent qualities of the progeny.

The term "grading" is in common use in America, and describes the continued mating of cows of a nondescript type with pure-bred bulls of some breed having the desired qualities. This method has been largely used in the past in building up several of the pure breeds of the present day. The scheme of the Dairy Shorthorn Association for the registration of the progeny of pedigree bulls out of cows of approved type embodies the principle of grading. This system offers the surest means of improvement where the owner of a herd of cows of mixed ancestry cannot see his way to dispose of his herd and replace it by cows of a pure breed.

In-breeding is the mating of closely-related animals, *e.g.*, sire and daughter, dam and son, and is the opposite of crossing. When this system is followed, there is great probability of the appearance in the progeny of the characteristics of the parents, and small likelihood of variation from the desired type. It is the surest and speediest of all breeding methods for fixing the characteristics which are desired, and it has been a predominating influence in the building up of most of our present-day breeds.

In contrast to its power for good, in-breeding, carried on unwisely, may cause disastrous results. Loss of size, constitutional vigour and breeding powers have in some notable cases followed from persistent in-breeding, and at the present day the practice of this system is uncommon.

Line-breeding describes the mating of animals that are more or less distantly related to each other. It might be called a modified form of in-breeding, because it embodies the same principle—that of concentrating and fixing family type and qualities. At the same time, the degree of relationship is not close enough to cause any serious risk of the development of the bad effects of in-breeding. This system is extensively followed in most of the pure breeds, and has given most satisfactory results. Close line-breeding would be exemplified by the use of two sires from the same family, each being mated with the

daughters of the other; this method is only practicable where a fairly large herd is kept and the bulls may be retained with safety. The mating of successive bulls from the same family with the progeny of each preceding sire would illustrate more distant line-breeding, and the adoption of this method is within the power of the average dairy farmer.

Pedigree and its Uses.—Pedigrees provide information on the ancestry of individual animals, and are of incalculable value to all breeders. It is only by a study of pedigrees that a breeder can obtain the information necessary to enable him to follow a system of line breeding. The description of a pedigree usually given, however, is incomplete and misleading. It is customary to trace the descent only through the female side, and often an animal is described by a family name when it traces its ancestry on the female side to some famous cow, although this cow may be only one of four great-grand-dams. The dam and grand-dams of the sire are just as important as the dam and grand-dams of the dam.

It is also most desirable that the statement of pedigree should be supplemented by reliable information as to the dairy qualities of the dams and the dairy prepotency of the sires. In this respect, milk records meet a great need, and the breeder would be helped materially if a uniform method of stating milk yields were adopted.

Definition and Measurement of Dairy Qualities.—Some definition of the desired dairy qualities is first necessary. Five may here be mentioned:—(*a*) large milk yield; (*b*) persistency of milk yield; (*c*) high milk fat percentage; (*d*) regular breeding powers; and (*e*) good constitution.

Of these qualities, (*c*), (*d*) and (*e*) are possessed, often to a high degree, by cows of beef breeds. They are not confined to the dairy breeds, but are included here in addition to the specific dairy qualities of a large and a persistent milk yield, because they are essential in first-class dairy cows of any breed.

It is next desirable to ascertain the extent to which these different qualities are related. Some information on the first four points has been collected through the agency of milk-recording societies, and the development of this practice should enable valuable data to be obtained. Milk recording, as carried out in England and Wales, collects information on the quantity and persistence of milk yields (*a*) and (*b*), and, where the cows remain in recorded herds, on breeding powers (*d*). Only in rare instances is information collected on fat percentage (*c*), and this

defect lessens the value of the work of the societies as an aid to the study of the inheritance of dairy qualities and to breeding in general. With regard to constitution (*e*), it may be inferred that no cow will give high milk yields and breed annually for, say, five or more years unless she possesses a very sound constitution, but the maintenance of constitutional vigour is closely associated with conditions of rearing, housing, feeding and the risk of incurring infectious or contagious disease. The question of feeding is important, since a heavy milker may break down after a few years if she has been poorly fed.

With regard to the correlation between the other qualities, the opinion is commonly held that a large milk yield is usually associated with a low percentage of fat, and *vice versa*, and that heavy milkers are less regular breeders than those giving lower yields. The actual correlation between these and other points can only be arrived at after careful study of a large amount of information, but the breeder is not so much interested in the degree of relationship found in a large number of animals between, say, large milk yield and high fat content, as in the discovery of individual animals which possess *both* these qualities. If it be a general rule that high yields are associated with low fat content, it is the *exceptions to the rule* that form the breeder's opportunity for the improvement of his herd. Such exceptions are fairly numerous.

In this connection it is important to record the conclusion of Professor Wilson.* after the study of several thousands of records of Ayrshire cows, that the inheritance of quantity and quality—high yielding capacity and fat percentage—are independent of each other. It should, therefore, be possible to unite in the progeny of selected parents the two qualities of large yield and high percentage of fat.

Inheritance of Dairy Qualities.—This conclusion leads directly to a consideration of the inheritance of dairy qualities. Can it be said that cows which are found to possess one or more of the qualities referred to pass these on unfailingly to their progeny? Every breeder knows his own disappointments in this matter. Cows with high records, even when mated with most carefully selected bulls, fail to transmit their qualities to their offspring, while others with moderate records have progeny which excel their dams. As illustrations of the uncertainty which is often met with, the following details, taken from the

* *Scientific Proceedings of the Royal Dublin Society*, Vol. XII. (N.S.), No. 3, July, 1910.

records of the herd of non-pedigree Dairy Shorthorns at the University College Farm, Reading, may be interesting:—

Dam.	Daughters.	Grand-Daughters.
ROSE (No. 16) 7 L.P.—9125* lb. 45·7 wks. 11 wks.	ROSAMOND (No. 47) by "A" 5 L.P.—11397 lb. 50·6 wks. 9·6 wks.	ROCK ROSE (No. 58) by "C" 3 L.P.—6058† lb. 36·3 wks. 15 wks.
	ROSABELLE (No. 49) by "B" 4 L.P.—7098 lb. 41·2 wks. 9·8 wks.	
	ROSEMARY (No. 55) by "C" 2 L.P. 8003 lb. 42 wks. 9 wks.	
FILLPAIL (No. 28) 1 L.P.—5036 lb. 37 wks. 8 wks.	FILLPAIL (No. 46) by "A" 1 L.P.—1083 lb. 13 wks.	FILLPAIL (No. 57) by "C" 3 L.P.—7792 lb. 40·6 wks. 12·7 wks.
		BELINDA I. (No. 50) by "C" 1 L.P.—4191 lb. 29 wks.
BELL (No. 7) 2 L.P.—8225 lb. 43 wks. 13 wks.	BELL (No. 41) by "A" 6 L.P.—9891 lb. 45·8 wks. 15·3 wks.	BELINDA II. (No. 61) by "C" 1 L.P.—3468 lb. 32 wks.
		BELLA (No. 67) by "D" 1 L.P.—2063 lb. 25 wks.

"A"—a pedigree Dairy Shorthorn bull and sire of heavy milking stock (see p. 655).
"B"— " " " "
"C"— " " " " and the sire of stock giving good yields (see p. 655).
"D"— " " " " and the sire of stock giving fair yields.

The figures under each cow show the number of lactation periods, the average milk yield, the average number of weeks in milk and the average number of weeks dry.

* 2 quarters only for 5 lactation periods.
† 3 " " 2 " "

The progeny of the cow Rose (16), though by three different sires, have been very good dairy animals; one of them, Rosamond (47) by bull "A," especially so. The daughter of Fillpail (28) by the same bull was a complete failure as a milker (see Fillpail (46)), but the daughter of Fillpail (46) by bull "C" is an excellent cow.

Bell (7) was a good cow, and her daughter by bull "A" was even better. The latter's daughters, however, have been disappointments, though two of them were by bull "C," the sire of the good cow Fillpail (57).

The system of breeding followed in the herd from which the above details were obtained partakes more of grading than of any of the other systems described, and is fairly representative of the methods followed by the progressive dairy farmer. The degree of uncertainty as to inheritance of these qualities is probably less in some pedigree herds where a line-breeding system has been followed, and also less in the single purpose dairy breeds than in those which claim dual purpose qualities.

The experience of breeders, nevertheless, has made it clear that cows which are good dairy animals do not necessarily have the power of passing on their own good qualities, either to their female or male progeny. This leads to a most important conclusion—that the *ability of a cow to transmit* its productive qualities is *distinct from* the *possession of* these qualities. We may therefore add another to the list of dairy qualities already given—(*f*), ability to pass on productive capacity to the progeny. From the breeder's point of view, this is the most important of all qualities, and if, in addition to the possession, to a more or less marked degree, of those qualities previously mentioned, the animals possessing it can be identified, some real progress has been made towards "certainty" in breeding.

Breeding Value shown by Progeny Records.—Up to the present the only method whereby the possession of such prepotency can be discovered is by a study of the actual records of the *progeny*. With dairy stock, this requires a much longer time than with beef stock. It is possible in two breeding years to ascertain with a considerable degree of certainty the quality of the progeny of a beef cow, and still more so of a beef bull. With dairy stock, however, until external appearances can be more accurately interpreted, three or four breeding years must pass before the milk records of the progeny show the actual powers of transmission possessed by their parents. In the case of cows this delay is not serious, but with bulls it means that, as a rule, the sire is slaughtered some time before his real powers as a getter of dairy stock can be known.

In herds of pedigree stock, bulls are frequently retained until well on in years, but in the past in this country it has not been the practice to determine the breeding value of such bulls by a study of the records of the progeny. It is quite probable that some such bulls have been retained because of their dam's or their own showyard record, or for other reasons which have no appreciable bearing on the transmission of dairy qualities.

There is some indication that this new point of view in the

judging of dairy bulls is gaining ground, particularly among Friesian breeders, but it is so important that it deserves widespread publicity. This should lead to a fuller realisation of the very true saying among farmers, that "the bull is half the herd."

For the purpose of obtaining a progeny record of a bull, it is necessary to have the milk records of the dams as well as those of the daughters, and the breeding value of the bull can be judged by the difference between the average record of the former and of the latter. To illustrate this important point, the progeny records of two bulls used in the herd at the University College Farm are shown below :—

Progeny Records of Bull "A."

	Dams.	Daughters.
Number of Animals	8	8
Number of Lactation Periods ...	20	20
Average Yield per Lactation Period	8518 lb.	8479 lb.
Loss per Lactation Period		39 *lb.*
Average Lactation Period	46·4 wks.	44·3 wks.
Average Dry Period	10·0 wks.	11·3 wks.
Average Period between Calvings	56·4 wks.	55·6 wks.
Gain between Calvings		0·8 *wks.*

Note I.—The dams were a selected group of cows purchased from different places, and they show a remarkably high average yield.

Note II.—The 20 lactation periods of the daughters comprise more first and second periods than the 20 of the dams, and a larger proportion of these periods commenced during the summer months, thus handicapping the daughters. When these two conditions are taken into account, it can confidently be said that the daughters were superior to the dams, showing that Bull "A" possessed exceptional breeding value for milk production.

Progeny Records of Bull "C."

	Dams.	Daughters.
Number of Animals	9	12
Number of Lactation Periods ...	20	25
Average Yield per Lactation Period	8001 lb.	6468 lb.
Loss per Lactation Period		1533 *lb.*
Average Lactation Period	43·3 wks.	38·3 wks.
Average Dry Period	10·1 wks.	13·6 wks.
Average Period between Calvings	53·4 wks.	51·9 wks.
Gain between Calvings		1·5 *wks.*

Note I.—The dams include cows purchased for their apparent milking qualities, and several of the daughters of Bull "A." The average yield is notably good.

Note II.—The 25 lactation periods of the daughters include 5 more first and second periods than the 20 of the dams, and to a certain extent this handicaps the daughters. The season of calving gave no advantage to either group. The yields show that Bull "C" lacked the breeding value for milk production of Bull "A," but was nevertheless a useful dairy bull.

The above results show that Bull "A" was capable of siring female progeny which gave an average milk yield of 8,479 lb. in an average lactation period of 44·3 weeks, and which were at least equal to their dams in productive powers. The heifers and

cows got by Bull "C" averaged 6,468 lb. in 38·8 weeks, and failed to equal the record of *their* dams by 1,533 lb. These figures show conclusively that "A" was much the better bull for breeding purposes; he was, in fact, a bull worthy of a place in the best pedigree Dairy Shorthorn herd in the country. Unfortunately, following the usual custom, he was sold for slaughter before any of his progeny came into milk.

Progeny Tests of Bulls.—It is obvious that information from progeny records cannot be obtained in a short time, and that the extended use of bulls which have proved their value involves a change in practice in regard to the age to which bulls are kept. Under ordinary conditions, bulls are used for two to three years, and fattened for slaughter when three to four years old. So long as this practice is continued, the use of tested sires is impossible. With the larger breeds of dairy cattle, a bull will be four to four and a half years old before the oldest of his heifers calve down, and about five years old before they complete a lactation period. It may be possible to form a reliable opinion as to the *lack* of dairy qualities of these heifers by their poor udder development before, and low milk yield just after, calving, but, if the heifers promise well, it is not possible to distinguish between the good and the very good until well on in the lactation period. The progeny test, therefore, can only give information in terms of milk yield for bulls of five years and over, and to be of maximum value the bulls must be healthy and active for some time thereafter.

In herds of pedigree stock, it is not uncommon to find bulls kept for as many years as they retain their usefulness, but the dairy farmer with non-pedigree cows sees many difficulties in keeping a bull until he is five years' old. If the farmer is to avoid in-breeding, a second bull must be bought to serve the progeny of the first one, and few herds are large enough to warrant the keeping of two bulls; while old bulls occasionally develop bad tempers and become dangerous to handle, but this difficulty may largely be overcome by more careful housing, handling and regular exercise. Further, the possibility that, should the progeny test show the bull to be very deficient in power to transmit dairy qualities, the cost of two additional years' keep will be incurred without any return, makes farmers less willing to undertake the trial.

The most economical solution of this difficulty appears to lie in the co-operation of two or more neighbouring farmers. Two promising bulls might be purchased for two herds, on the understanding that during the first three years they should be used

approximately equally in both herds, and if one bull were found to be of great dairy prepotency, he would be kept as long as possible for mating with mature and unrelated cows. Under these conditions, however, judicious in-breeding most probably would give very satisfactory results. Such a scheme could be worked equally well with three participants. The same system could be followed without the risk of differences of opinion where one owner maintains a large herd or has cows at two or more homesteads. Young bulls would be required from time to time for mating with heifers, as is the custom at present.

The co-operative societies of small holders organised under the Ministry of Agriculture's Live Stock Improvement Scheme could adopt the tested sire system. Bulls could be transferred from one society to another, and the societies would have the advice and assistance of the Live Stock Officer at all stages. The period necessary for a progeny test could also probably be shortened by good management and feeding of the young stock, and by mating at an earlier age than usual.

Owners of pedigree herds who have confidence in the bulls they offer for sale might also come to some agreement with purchasers as to the retention of a bull for the necessary time, since, when a specially good bull is found, the family from which he is bred immediately increases in value.

Progeny Tests of Cows.—Tests of the power of transmission of dairy qualities in cows are not, of course, of the same importance as in the case of bulls. A cow will, on the average, have but five or six calves in a breeding herd, and as only half of these may be heifers, individual cows with the maximum power of transmission can, through their female progeny, make only a small contribution to the improvement of the herd. The basis of selection of cows for breeding must, nevertheless, be facts—not opinions—hence the need for a great development of milk recording to supply information on the degree to which dairy qualities are possessed by cows in the herd. The need for constitution must also be kept in mind; and, lastly, "foundation" cows should exemplify to a marked degree the type and characteristics of the breed.

Registers of Heavy-milking Cows and of Dairy Bulls.—Reference may also be made to the formation of registers of heavy-milking cows in relation to the breeding of dairy bulls. Registers of cows complying with certain conditions as to minimum yield, and other particulars, are now compiled by the Ministry of Agriculture, the Dairy Shorthorn Association, and at least one Breed Society, and one of the advantages claimed

for such registers is that they afford a basis for a register of bulls out of cows with authenticated yields. The emphasis already laid on the distinction between *possession* of dairy qualities and *power of transmission*, and on progeny tests, indicates another basis which might be adopted for entry into a register of bulls.

A register of bulls which have a minimum number of female progeny *qualifying for entry* into the registry of heavy milking cows will be a more valuable guide to breeders than a list of bulls out of registered cows. The entry of a bull into such a register would add greatly to its own value and to the value of its family, and the information would be an invaluable complement to pedigrees and of great assistance in selecting animals for any particular application of the line-breeding system.

Summary.—From the individual breeder's point of view, success in breeding for milk production is most likely to be attained by working steadily towards an attainable ideal embodying type, constitution, breeding powers and dairy qualities; by the selection of cows conforming as closely as possible to this ideal; by the study of pedigree and milk records; and by the use of bulls, good animals in themselves, and possessing some considerable degree of concentration of the blood of a family of cows (*i.e.*, line bred) showing the desired type and characteristics, and the required degree of dairy qualities. If an aged bull of the desired breeding and the sire of progeny of known merit can be obtained, a definite advance should be assured.

From the breed point of view, success lies in the direction of the identification and increase of families and animals possessing breed characteristics, dairy qualities, and the power of transmitting them to the utmost possible extent; the adoption of a uniform method of stating milk yields; the certification of milk yields and percentage of fat by an external authority; the development of registers for heavy-milking cows, with classes for different ages from the age at first calving to maturity, and the formation of registers of bulls with a minimum number of daughters entered in the heifer and cow registers.

From the national point of view, breeding for milk production would be assisted by the inauguration of a scheme for the collection of data on the possession and inheritance of dairy qualities and for the study of this data at the Institute for Research in Animal Breeding.

THE LIFE HISTORY OF THE COMMON MOLE

(Talpa Europea).

LIONEL E. ADAMS, B.A.

MOST people have learnt that the mole is an insectivorous burrower with a cylindrical body covered with black velvety fur, which rises vertically from the skin. This peculiarity is alleged to have been acquired to enable the animal to move both backwards and forwards in its narrow tunnels without brushing the fur "the wrong way." Although it is true that the vertical fur can be smoothed in any direction, it is most unlikely that the peculiarity has been acquired for this purpose, since the animal can, with one or two strokes of his powerful fore-paws, clear enough space to turn round in a couple of seconds. In all probability the upright fur is useful for avoiding the retention of earth, and is easily scratched clean.

The mole's range, so far as the United Kingdom is concerned, embraces the whole of Great Britain, but not Ireland. It is found on the summits of our highest hills wherever worms exist, but is most plentiful in the low-lying plains. It may also be found burrowing on the sandy sea shores, even as far as the tide marks.

In order to follow the mole's career it will be convenient to start with an account of the courtship of the parents.

In early spring both sexes, especially the boars,* travel in search of mates. Their wanderings may often be recognised by small furrows, or tunnels so near the surface as to lift the soil in a ridge. These travelling runs are different from all other runs in that they are always in a straight line; they are usually called "rutting runs," although there is no evidence that pairing takes place within them. The meeting of the boars and sows is fortuitous and promiscuous, no pairs having been known to inhabit a nest together. The female prepares a special nest as a nursery on a somewhat similar but simpler plan than the winter fortress, which will be described later. So far as the writer is aware, no mammal prepares a nursery until well advanced in

* The sex names are "boar" and "sow."

pregnancy. If this holds good with regard to the mole, six weeks rather than one month is nearer the actual period of gestation, as some nests from which the writer has taken young had been made about a month previously.

The following evidence is sufficient to prove that the female *litters only once a year.*

Hundreds of dissections at all times of the year show that an enormous development of testes, prostate and corpus spongiosum takes place in the male commencing late in January, and culminating about the end of March or the beginning of April, when pairing takes place. These organs afterwards decrease in size, until by the end of May they have become normal again. They remain in this condition during the rest of the year.

There is thus only one short "rutting" season, practically confined to the latter part of March, April, and perhaps occasionally the beginning of May, after which both sexes are completely exhausted. The earliest personal record the writer possesses for a fœtal litter (which was within three or four days of birth) is 13th April, and the latest date he has seen young in the nest is on 25th June; these young moles were quite ready to leave the nest.

Thus, on the assumption that the period of gestation is four weeks (it is probably rather more) it is evident that the female would not have time to breed twice within the time mentioned during which young are found, even, as is not the case, if she were in condition to do so. Moreover, these limits of earliest and latest births are not those of the same year or locality, so they may be fairly curtailed, and a month of courtship may be presumed to be the limit of the mole's capacity.

The average number of young in a litter works out at rather more than 3·5. The writer's personal records are as follows:—

1 litter containing 1 young.
4 litters containing 2 young.
20 litters containing 3 young.
31 litters containing 4 young.
4 litters containing 5 young.
1 litter containing 6 young.

The writer selected one mole for measurement from each of several litters, and others from the same nests at intervals, and has prepared the following table of the rate of growth and concomitant personal appearance from the day of their birth to the twenty-second day, when they are ready to leave the nest. The measurements are in millimetres.

Number of Days old	Head & Body	Tail	Hind Foot	Colour	Remarks
1	42	8	5	Very red	Umbilical cord unhealed.
2	47	9	5·5	Red	Ditto.
3	52	10	6		
4	57	11	7		
5	62	12	8	Pink	
6	67	12	9		
7	71	13	9		
8	76	14	10		
9	80	15	11	Slightly lead coloured on back	
10	85	15	12	Slightly darker	
11	89	16	13		
12	94	16	14	Ditto	
13	99	17	15		
14	105	17	16	Lead colour all over; fur visible	
15	109	18	16		
16	112	21	16		
17	114	23	16	Completely covered with velvety lead-coloured fur	Ears open
18	115	23	17		
19	116	24	17		
20	117	25	17		
21	117	26	17	Fur nearly normal colour and length	Eyes showing a spot of matter; not yet open
22	118	27	17	Fur nearly normal	Eyes opening

During the summer and early autumn moles come to the surface in search of worms and to drink, the dewy herbage supplying the latter need. In the hot year of 1911 the surface of the ground in certain districts was caked so hard that the moles could not burrow through, and numbers of those which came above ground by their usual exits were unable to dig themselves in again, and so perished. One farmer stated that he used to go out at night with his dog, and killed over 300 on his own farm. In some parts of south Surrey the mole was almost exterminated.

The Mole's Fortress.—As autumn draws on, the impulse seizes the mole to prepare a winter habitation which is known as "the fortress."

Much legendary inaccuracy has been handed down about the mole and its fortress. It has been repeatedly asserted that the mole deliberately chooses the most suitable spot, preferably "in

the foundation of a wall, under a hedge, or at the root of a tree." In the vast majority of cases, however, the fortress is placed in the open field, and seldom in the situations indicated above, although very occasionally the writer has found fortresses near hedgebanks and under trees; in these instances the mole most probably was not aware of the tree. Abundance of food, nevertheless, does influence him in his choice, in so far as being satisfied with his locality, he encamps upon it. To imagine, however, that a practically blind animal of the mole's impatient disposition and subterranean habits can make a deliberate choice of the most favourable spot after a survey of the surroundings, is absurd.

Everyone is familiar with the time-honoured figure of the plan of the fortress. Originating from Geoffroy Saint-Hilaire and elaborated by Blasius, it has been copied by every succeeding writer without the slightest attempt at verification, until the publication of the works of J. G. Millais,* and the late Major Barrett-Hamilton.† The old text-books referred to this fortress as though all were constructed exactly alike on a pre-arranged plan of labyrinthine escapes from enemies above and below, whereas observation shows that the more or less complicated galleries are purely incidental in piling up a protecting heap over the excavated nest; there is one exception, however, which will presently be described.

The first act in the making of the fortress is the excavating of the nest cavity at some point in one of the usual tunnels. This cavity is spherical in shape and about the size of a man's head, and is just below the surface of the ground. The earth is ejected through a hole in the top in the same way as an ordinary molehill is thrown up, viz., by forcing the earth up with the top of the head in quick jerks.

As the ejected earth piles up, the mole must penetrate the heap and reach the surface, and in this way a tunnel is made. The nest cavity made, the next proceeding is to excavate the bolt run. This is a tunnel leading downwards from the bottom of the nest perpendicularly for some 6 inches, when it curves upwards and opens into the original tunnel leading into the nest cavity.

In order to protect the nest from enemies and weather, the mole proceeds to pile up a huge mound of earth on the top of the heap already over the nest, by further tunnelling outside the nest. In the process tunnels are formed within the mound,

* The Mammals of Great Britain and Ireland.
† A History of British Mammals.

the heaping up always being from below the surface. Dissections of hundreds of these fortresses plainly reveal the fact that they are not purposely made as escapes, but are purely incidental to the work for the protection of the nest. It is astonishing how well these tunnels keep their shape and do not fall in; probably their sides are tightly pressed by the working of the mole as he pushes the loose earth through them.

When complete the fortress is from 12 to 14 inches high and 3 to 4 feet in diameter. The nest cavity is filled with grass or leaves; in it the mole lives throughout the winter. The writer has known a large fortress erected in one night.

The nursery made by the female in spring is quite distinct. It is on the same plan as the fortress, but it very seldom has a bolt run, and is usually on a smaller scale.

When a mole erects a fortress on the same spot in the following year, he never uses the nest cavity previously made, but constructs a fresh nest in the mound close to the old one. The writer has found three such nests, each built on the top of the preceding one.

The Food of the Mole.—The mole is an insectivorous animal, but, like shrews, hedgehogs and others, it is also carnivorous. Examinations of stomachs made by the writer and others all tend to show that worms are the staple diet, but that any grubs, leather-jackets, and such like insects are eaten with equal readiness. The vegetable matter found in their stomachs is swallowed inadvertently in the hasty gulping down of their prey. The writer has watched his captives feed on worms. The mole, after seizing a worm with his mouth, would hold it down with his paws, and with his snout feel the way to one end (as often the head as the tail) where he would eat the worm, moving the while to the other end by a series of quick jerks. Sometimes he has brushed away the external earth from a worm with his snout and paws before commencing to devour it. On one occasion a large lobworm had burrowed nearly out of sight, when the mole found and seized it, but instead of tugging at the creature furiously and thereby breaking it and losing a portion, he held the worm taut and presently, yielding to a gentle strain, it was secured whole. This act shows that the moles acquire a remarkable experience of catching worms.

On another occasion, when a captive had been fed until he could eat no more, he seized a worm, bit it with quick bites along its whole length, and then crammed it into the earth,

left it, and turned about to find another. He was given another large lobworm, which he treated in exactly the same way, thrusting it into the same hole, which he immediately covered up by scraping the earth over it with his paws. On two other occasions the writer has seen a captive bury worms and also a dead mouse in this manner. The moles would eat dead mice, but preferred worms and slugs.

Moles have been accused by gamekeepers of eating the eggs of pheasants and partridges, but it is doubtful whether this accusation is altogether justified. It is possible that if an egg were to fall into the mole's tunnel as he was operating beneath the nest. He described the mass as "three spadefuls." This, but the writer has evidence of eggs being ignored by the mole.

There is an old story of moles storing worms, which appears to have some foundation. A farmer on whose land the writer was trapping moles told him that on digging out a fortress he came across a mass of worms in the nest cavity close beside the nest. He described the mass as "three spadefuls." This taken in conjunction with the writer's own observations of their burying habit, removed his previous scepticism on this point.

The mole does not hibernate, but wakes up in his warm nest in the fortress about every four hours, when he goes in search of food. His tracks have often been found in the snow.

Is the Mole blind?—Observations seem to point conclusively to the fact that the mole is practically blind.

When a worm is placed near a mole the latter immediately shows signs of excitement, being aware of its proximity by smell or hearing, but it is only after poking about with his snout that, haphazardly, he comes upon it. He never goes straight for a worm, and when a half-eaten worm is dropped and has crawled away a little, the same hunt for it is repeated.

The test of waving a lighted candle before captive moles has been tried, and it was found that the animals took no notice of the light. Moles met with casually in a country lane also have never endeavoured to get out of the way so long as they were not actually touched.

It is remarkable how soon captives become tame, or rather, indifferent to being handled. When first caught they squeak and bite viciously, but half an hour afterwards they have allowed themselves to be taken up by the skin of the back without any resistance. The writer has frequently stroked and tickled his captives while they were engaged in eating, and has held them up by the tail while they lapped water. He

taught one captive to come for food at the sound of scratching the earth or the side of its box.

Enemies of the Mole.—The mole's natural enemies in Great Britain are few and incidental. Our native snakes are not able to tackle so large a prey successfully, although adders have been said to swallow them.

The weasel has often been caught in mole traps set in the runs, and doubtless the larger stoat preys upon moles occasionally, but it is not likely that the stoat can follw the mole along the runs.

The heron probably snaps one up by the waterside now and then, as this bird has been known to swallow a nearly full-grown water vole.

The writer has often found moles' skulls and bones in owls' pellets. He once possessed a fox terrier which would hunt moles successfully, scratching one out of a molehill beneath which it was working, but the dog would never treat the moles seriously as he would rats, and he never troubled to shake or kill them.

Mole-catchers have asserted that foxes dig out and eat the young, and that badgers will dig up traps and eat the dead moles out of them.

It does not seem that rooks prey on moles, although crows may do so, and the larger hawks may account for a few.

Man, of course, is the mole's greatest enemy, especially now that the skins have a commercial value.

Whether the mole is harmful or beneficial to agriculture of course depends entirely upon local conditions. On heavy soil the tunnels are useful as drains, and the earth turned up serves as top dressing when spread by bush-harrowing; but on pasture land, if mole heaps are too numerous, a large percentage of surface is lost. In mowing grass the heaps are a great nuisance, as they clog the machine cutters. The mole's surface burrowing is also injurious to all crops when in the seedling stage. The animals consume many of the farmer's enemies, and never vegetable matter, except a very trifling amount swallowed inadvertently.

ACCESSORY FOOD FACTORS, OR VITAMINES.

THE reference in the June issue of this *Journal* to Sir Daniel Hall's Third Chadwick Lecture, in which a short account of "vitamines," or accessory food factors, was given, has led to a request for the publication of further information on the subject. A full account of the present state of knowledge concerning accessory food factors, by the National Health Insurance Medical Research Committee, was published in 1919, and the account here given is a summary of that report.*

Accessory food factors—so called because the foods in which they are present contain them only in minute amounts—play a prominent part in nutrition, since, if these minute amounts are removed from natural foods, such foods fail to maintain healthy nutrition, and grave symptoms of actual disease may supervene. Among the diseases which have definitely been shown to be produced by the absence of these factors are scurvy, rickets and beri-beri. Research suggests that the nature of vitamines is quite distinct from that of proteins or of foods which supply energy, but at present we have no knowledge concerning their actual chemical nature. It is thought that they may either (*a*) be structural components of living tissues of which a supply is essential, though quantitively unimportant, or (*b*) that they may act rather as catalysts in certain normal processes of metabolism. There is evidence to suggest that these accessory food factors are formed only in the tissues of plants, whence they pass into the tissues of herbivorous animals and thus become available for carnivora.

Vitamines are always present in natural foodstuffs as instinctively consumed by men and animals; broadly speaking, it is safe to say that the individual always finds a sufficient supply of vitamines in his food, so long as that food is reasonably varied and has received no artificial or accidental separation into parts, and so long as no destructive influence has been applied to it.

Clear evidence has been obtained of the existence of three accessory food factors:—

(1) *Fat Soluble A Factor.*—This term was given to this factor by American investigators, as it is soluble in fats and accompanies them in the process of isolation from certain food-

* *Special Report Series No.* 38, *H.M. Stationery Office*, 1919, 4*s. net.*

stuffs: this factor is probably identical with that, the absence of which leads to rickets in young. This factor is in all probability synthesized by the plant, and its primary sources are found in the green leaves of plants and the embryos of certain seeds. Beyond these primary sources the main sources are certain fats of animal origin, such as butter. The distribution of this factor in foods will be found in the Table concluding this account.

This factor is gradually destroyed at 100° C. (the boiling point of water), and four hours' exposure to that temperature is sufficient to render butter-fat of little greater nutritive value from the standpoint of vitamine supply than an equivalent quantity of lard. The factor is also destroyed during the hardening of oil by the action of hydrogen, a process now widely employed for the preparation of edible fats such as margarine.

We as yet know nothing definite of the part this factor plays in the nutrition of the body. Storage of the factor appears to be particularly marked in adult animals, and the requirements after maturity is reached are of a smaller order than those of the growing young. Such storage is of considerable importance to the pregnant and nursing mother, for she can provide her young with a high concentration of this factor without immediate dependence upon an external supply.

(2) *Water Soluble B Factor.*—This term is also that of American investigators, this factor being soluble in water; and it is probably identical with the anti beri-beri and anti-neuritic factor. The primary sources of this factor also are provided by the plant kingdom. It is widely distributed, having been found in all the natural foodstuffs examined, and it apparently exists free in the plant cell. The principal sources have proved to be the seeds of plants and eggs of birds. In cereals the largest deposit is found in the embryo or germ, the bran coming next, while the endosperm is deficient. This fact accounts for outbreaks of the disease beri-beri among peoples existing on a diet of polished rice.

The requirements of the body for this factor are much greater during growth than maturity, and the large deposits in seeds and eggs suggest a due provision made for the wants of the young offspring during the early period of life. It does not seem that the normal animal possesses any large reserve of the water-soluble factor in an available form, and while (as in the case of the fat soluble factor) the quality of the milk of the

nursing mother will suffer if her diet becomes deficient in this essential, the adverse effects here are much more rapid owing to the smallness or absence of such reserve supply.

The factor withstands desiccation for long periods of time. Its resistance to heat is also considerable; destruction takes place very slowly at 100° C. (212° F.), but is much more rapid in the neighbourhood of 120° C. (248° F.). Tinned foods of all descriptions, with but few exceptions, would therefore be deficient in this vitamine.

The distribution of this factor in foods is given in the concluding Table.

(3) *Anti-Scorbutic Factor.*—The preceding factors are admittedly indispensable for growth as well as nutrition. The third or anti-scorbutic factor is undoubtedly indispensable for normal nutrition of certain species of animals, but in the light of present knowledge it is difficult to say whether it is indispensable as a component of a normal dietary for growth, because wide variations occur in the requirements of various species for this substance.

This vitamine is necessary in a diet for the prevention of scurvy, and is found in fresh vegetable tissues and (to a much less extent) in fresh animal tissues. Its richest sources are such vegetables as cabbage, swedes, turnips, lettuce, watercress, and such fruits as lemons, oranges, raspberries and tomatoes. Inferior in value are potatoes, carrots, French beans, scarlet runners, beetroot, mangolds, and also (contrary to popular belief) lime juice. Potatoes, although classed among the less valuable vegetables as regards anti-scorbutic value, are probably responsible for the prevention of scurvy in Northern countries during the winter, owing to the large quantities which are regularly consumed. Milk and meat possess a definite but low anti-scorbutic value.

This vitamine suffers destruction when the fresh foods containing it are subjected to heat, drying, or other methods of preservation.

All dry foods are deficient in anti-scorbutic properties: such are cereals, pulses, dried vegetables and dried milk.

Tinned vegetables and tinned meat are also deficient in the anti-scorbutic principle. In the case of tinned fruits the acidity of the fruit increases the stability of the vitamine, and prevents to some extent the destruction which would otherwise occur during the sterilization by heat and the subsequent storage.

Distribution of Vitamines in Foodstuffs.—The table here given shows the distribution of vitamines in the chief foods. The relative values of the foodstuffs are indicated by positive and negative signs. With increased relative value more than one positive sign is employed; a zero indicates the absence of the factor. Absence of a sign does not, however, indicate the absence of the factor.

Class of Foodstuff.	*Fat-soluble A Factor.*	*Water-soluble Bar-anti-neuritic (anti-beri-beri) Factor.*	*Anti-scorbutic Factor.*
Fats and Oils.			
Butter	+ + +	0	
Cream	+ +	0	
Cod-liver oil	+ + +	0	
Olive oil	0		
Cocoanut oil	0		
Linseed oil	0		
Fish oil, whale oil, herring oil, &c.	+ +		
Meat, Fish, &c.			
Lean meat (beef, mutton, &c.)	+	+	+
Fish, white	0	very slight, if any	
,, fat (salmon, herring, &c.)	+ +	,,	
Milk, Cheese, &c.			
Milk, cow's whole, raw	+ +	+	+
,, skim ,,	0	+	+
,, dried whole	less than + +	+	less than +
,, condensed, sweetened	+	+	,,
Cheese, whole milk	+		
,, skim	0		
Eggs.			
Fresh	+ +	+ + +	? 0
Dried	+ +	+ + +	? 0
Cereals, Pulses, &c.			
Wheat, maize, rice, whole grain	+	+	0
,, ,, ,, germ	+ +	+ + +	0
,, ,, ,, bran	0	+ +	0
Linseed, millet	+ +	+ +	0
Dried peas, lentils, &c.		+ +	0
Soy beans, haricot beans	+	+ +	0
Germinated pulses or cereals	+	+ +	+ +
Vegetables and Fruits.			
Cabbage, fresh raw	+ +	+	+ + +
Swede, raw expressed juice			+ + +
Carrots, fresh raw	+	+	+
Potatoes, raw	+	+	
Apples			+
Miscellaneous.			
Yeast, dried	?	+ + +	

The facts discovered so far are principally concerned with the causes producing diseases in animals, but there can be no question that further investigations will disclose that vitamines may play a part in the production of animal products (such as meat and milk) for economic purposes generally.

"DAMPING OFF" OF TOMATO SEEDLINGS.*

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THE disease of tomatoes known as "Damping off" is of common occurrence in nurseries in this country during the propagating season. At times it causes considerable damage, giving rise to serious financial losses. Cases are known where nurserymen have lost as many as 50,000 young plants in a season owing to this disease, and most growers have experienced anxiety as to it at some time or another.

Description.—The symptoms of the disease are readily recognised. The seedlings are attacked at the soil level or a little above it; the organism readily pierces the external skin and destroys the internal tissues. The latter collapse, assume a brown colour at the point of attack, and the seedling falls over. The action of the parasite is very rapid, 18 hours only being sufficient to cause death. Often the plant is attacked at a later period in its life, when it has been "pricked out" into pots or even planted in the houses; the symptoms are practically the same as in the seedling stage. This later appearance of the disease is often termed "Blackleg" or "Foot rot" by growers. The disease is usually caused by pathogenic organisms, but some discrimination is necessary, because the presence of injurious chemical factors in the soil may produce similar symptoms. Among the latter factors may be mentioned free ammonia and certain acids such as cresylic acid. The investigations here discussed deal only with the disease caused by pathogenic fungi.

Three different organisms have been found to produce "Damping off" of tomato seedlings in the Lea Valley, viz., *Phytophthora parasitica* (Dastur), *Phytophthora cryptogea* (Pethybridge) and *Rhizoctonia solani* (Kuhn). The disease organisms exist in certain soils as a definite infection, but are absent in others. The infection may be carried from one season to the next in the seedboxes and pots. Another frequent source of infection is the water supply. Examination of a large number of nursery waters showed that the above mentioned fungi were

* An abridged account of an investigation to be published in full in the *Journal of Applied Biology*, Vol. VII., No. 2, 1920.

present in several instances. Further work is being done in this direction, but in the meantime the importance of a pure water supply cannot be too strongly emphasised.

All precautions should be taken to avoid the wells being polluted by surface drainage from the nursery or any adjoining allotment or garden.

Many samples of seed have been examined, but in no case up to the present have the "Damping off" organisms been found on the seed.

Experimental Tests.—Different methods of making seed beds, sowing seeds, watering, &c., have been investigated to ascertain the relation of these operations to the incidence of the disease. A covering of sand, charcoal or lime either alone or above a covering of sterile soil produced only a small increase or decrease in the amount of disease. Charcoal had no effect when used alone as a covering to the seeds, while sand reduced the amount of diseased seedlings by 20 per cent. Five per cent. of charcoal mixed with the soil had a distinctly beneficial result; in addition to reducing the amount of disease, a fine crop of sturdy dark green seedlings was produced. In the case of lime, it was found that whether mixed with the soil or added as a covering to the seeds, this constituent apparently caused an increase in the amount of disease.

Sowings of seeds closer than 50 per box (14 in. by 9 in. by 2 in.) should be avoided, as the practice materially assists the spread of the disease.

Watering in the morning or evening is preferable to performing this operation at midday, while bottom watering, by standing the boxes in a shallow tray containing water half an inch deep for five minutes, is preferable to top watering. Dressings of nitrate of soda or superphosphate were found to have little effect upon the amount of disease, but half an ounce of sulphate of potash added to 5 lb. of soil resulted in a considerable reduction of the pest.

Many fungicides were tried, but only one gave any success, viz., a mixture of 10 parts of lime and 1 part of copper sulphate. Dry powdered lime, obtained by slaking caustic lime, and ground copper sulphate, were thoroughly mixed and spread over the surface of the soil at the rate of $\frac{3}{4}$ oz. per square foot, and disease on plants grown on this soil was reduced from 47 per cent. to 7 per cent.

A relatively high percentage of moisture in the soil and the air favours the rapid spread of the disease. Careful regulation

of the watering, so as to keep the seed boxes uniformly moist, and good ventilation of the propagating houses to dry out the surface soil, will produce the best moisture conditions for checking the disease. The optimum temperature for growth of *P. parasitica* is about 30° C. (86° F.), and that of *P. cryptogea* and *Rhizoctonia* about 25° C. (77° F.). Below 12° C. (54° F.) the growth of all three is very slow. If the disease starts, the grower should endeavour to keep the temperature down as far as possible, without impairing the health of his plants.

Sterilisation of the soil by heat or formaldehyde has proved the most effective method of controlling "Damping off." All strengths of formaldehyde solutions from two per cent. upwards are effective for soil sterilisation, but weaker solutions are not sufficiently strong to sterilise the soil completely. The method employed for sterilisation by formaldehyde is as follows:—

A two per cent. formaldehyde solution is made by adding one gal. of commercial formaldehyde (40 per cent. formaldehyde) to 50 gal. of water. Pots and boxes are sterilised by soaking them in the formaldehyde solution for ten minutes and then placing them in a heap and covering with sacking for 48 hours in order to allow the vapours of the formaldehyde to act. After this period the sacking is removed and the boxes are allowed to dry. They may be used as soon as the smell of formaldehyde has vanished. The soil may be sterilised, either in the boxes or in a heap. In the first case the boxes are filled with soil and the formaldehyde solution is poured on until the former is saturated. About a pint of solution is necessary for 5 lb. of soil of average wetness. The boxes are then covered with glass for 48 hours to keep in the vapours. At the end of this period the covers are removed and the soil is allowed to dry. When the formaldehyde vapours have evaporated, usually a week or ten days after removing the covers, it is safe to sow. Soil may be sterilised in a heap by saturating it with the formaldehyde solution, covering with sacking for 48 hours, and allowing it to dry before using.

Summary of Methods of Control.—The following points should be observed:—

1. A pure water supply should be used.

2. All seed boxes, pots, and propagating soil should be sterilised by heat or formaldehyde.

3. If "foot rot" has been prevalent in the houses during the last season the soil should be steamed.

4. The watering should be carefully regulated, and water-logged conditions or a saturated atmosphere in the propagating houses never allowed.

5. The propagating houses should be thoroughly ventilated, and a uniform temperature of about 55°F. maintained, if the disease appears.

6. Any diseased seedlings should be picked out and destroyed by burning as they appear.

7. A top dressing of 10 parts lime and 1 part copper sulphate applied to the soil at the rate of $\frac{3}{4}$ oz. of the mixture per square foot will help to reduce the amount of disease.

PERENNIAL RYEGRASS AND WILD WHITE CLOVER.

PROFESSOR GILCHRIST of Armstrong College, Newcastle-on-Tyne, who has arranged to deliver a series of lectures in the North of England in connection with the Ministry's grassland campaign, addressed a meeting of farmers at Thirsk on 16th August, at which he laid great emphasis on three important points in grassland improvement:—

(1) The benefits following the inclusion of wild white clover in seed mixtures.
(2) The value of perennial ryegrass, and the proper method of retaining and developing this grass.
(3) The improvement of turf which results from proper treatment of grass.

Wild White Clover.—At Cockle Park, as the outcome of many years' experience, 1½ lb. of wild white clover seed per acre are now usually included in the seeds mixture for a ley of three years or longer duration. A fair proportion of wild white clover plants in the aftermaths of one-year leys has been produced with ½ lb. or even ¼ lb. of seed, but the first year's aftermath in three-year leys, for which 1½ lb. of wild white clover seed has been included in the mixture, is much more satisfactory, a good covering of clover being quickly obtained, effectually checking the development of weedy herbage which is otherwise rapid. The seeds mixture for three-year leys on this poor clay is as follows:—16 lb. perennial ryegrass, 10 lb. cocksfoot, 4 lb. Timothy, 4 lb. late flowering red clover, 1 lb. trefoil and 1½ lb. wild white clover. The rotation is a six-course one, and since 1912 there have been five 3-year leys from which the average weights of hay in the first, second and third years have been 42 cwt., 45 cwt., and 38 cwt., per acre respectively. Such excellent results in the second and third years are undoubtedly due to the inclusion of wild white clover. The clover aftermaths have been of a most valuable character for grazing, and as good in the second and third years as in the first, while the turf at the end of the three years is always excellent.

The effect of including wild white clover in the seeds mixture was further tested on Tower Hill Field in 1907-1917 on poor stiff clay soil of low value. An addition of 4 lb. wild white clover seed per acre to the mixture increased the hay crop by 6 cwt.

per acre for each of the first three years, by 20 cwt. annually for the next three years, and by 8 cwt. annually for the last five years. The benefit was thus greater in the later years than in the earlier, and the average crop of hay per acre for the eleven years was 34 cwt. with wild white clover and 23½ cwt. without. Wild white clover increased the hay crops not only by its own herbage but also because the nitrogen collected by its roots stimulated the grasses growing with it. Better grasses are now growing on the wild white clover plot: there are fewer weedy grasses and less weedy herbage; the hay throughout has been superior in quality, and the aftermaths have been much more valuable.

Treatment of the Ley.—A good seed bed is of the greatest importance, especially when land laid down from recently ploughed out old turf is sown away. Such old turf specially requires good harrowing to get a tilth, and rolling well to get a firm seed bed. The best seed bed will be obtained when seeds are sown with a cereal crop like barley, in spring. If the land is heavy, ploughing should be completed in early winter, so that the frost may pulverise the surface. At Cockle Park the experience is that grass and clover seeds are likely to do best when sown immediately after a spring-sown corn crop.

In the case of the three-year leys instanced by Professor Gilchrist, 10 cwt. per acre of basic slag (39 per cent. phosphates) was applied to the young seeds as soon as possible after the barley crop was harvested. This was the only manure used throughout each period of three years. On Tower Hill Field 10 cwt. per acre of basic slag (39 per cent. phosphates) has been applied every third year.

Late Flowering Red Clover.—It will be observed that the mixture used for the three-year leys includes late flowering red clover as well as wild white clover. This is due to the fact that clover sickness gives much trouble at Cockle Park, and late flowering red clover gives better results than ordinary red clover.

Perennial Ryegrass.—In the past, the usual experience of farmers has been that perennial ryegrass remains a good plant only for a few years, and, under ordinary conditions, weedy herbage then takes its place. Professor Gilchrist explained this failure as being due largely to the absence of close grazing and heavy treading by stock. Probably no grasses stand close grazing and heavy treading better than do perennial ryegrass.

and crested dogstail; it is under such conditions that they are encouraged. The more a pasture is trodden down, and, up to a certain point, the more closely it is grazed, the more nutritious will be the pasture and the more numerous the head of grazing stock which it will carry. Several instances were cited by Professor Gilchrist, viz.:—

(1) In Tree Field and Hanging Leaves Fields at Cockle Park, which originally contained bents, wiry fescues and carnation grass, perennial ryegrass is now in many cases the dominant grass where the pastures are effectually improved and most closely trodden and grazed.

(2) Examinations of the old turf on Newcastle Town Moor and many other old turf pastures show that where the herbage is closely grazed and most nutritious, perennial ryegrass and crested dogstail are largely developed.

(3) Sir Henry Gilbert noticed at Rothamsted that perennial ryegrass was found abundantly in old pastures that were regularly grazed, but only sparingly where the old ley was regularly mown for hay. He stated his conviction that close grazing did much to develop perennial ryegrass.

(4) In a large field in Northumberland, which was sown down seven years ago, it was found that where wild white clover was sown with perennial ryegrass only, and slagged, closely grazed and heavily trodden, a pasture of high feeding value was developed. If no wild white clover had been sown, and if the field had not been slagged, it is probable that there would have been no plants of perennial ryegrass and that the pasture would have been worthless and full of weeds.

It is very desirable that stocks of perennial ryegrass should be obtained from old leys, as they will probably prove of much greater value for purposes of permanent pasture. Peacey's perennial ryegrass was selected from meadows in the Cotswold valleys at the end of the 18th century. It was claimed for this that it had "early growth, larger crops, grateful flavour, nutritious food and permanence."

Improvement of Turf.—To illustrate the improvement of turf which follows the treatment outlined above, viz., presence of wild white clover and perennial ryegrass, application of basic slag, and close grazing, Professor Gilchrist exhibited

contrasting specimens of turf from Cockle Park. Two, of wild white clover and perennial ryegrass, were from poor clay loam soil from Palace Leas Field (meadow hay). Where sulphate of ammonia had been regularly applied, the specimen showed an accumulation of dead organic matter, about 3 inches deep, on the surface, effectually preventing rain from penetrating it and resulting in a dry condition of the soil beneath. Where basic slag had been used the specimen showed no dead organic matter, but a sweet and nutritious grass and clover herbage, and the turf was greatly enriched by an abundance of clover root, which rain could penetrate. The amount of nitrogen in the surface of 6 inches of soil is greater by about 400 lb. per acre (the equivalent of 22 cwt. nitrate of soda) in the basic slag turf than in the sulphate of ammonia turf. A similar contrast was exhibited by turves from light sandy soil in Davy Houses Field, which is very old pasture. Unmanured turf consisted mainly of poor, wiry bent and fescue grasses, with stunted and starved wild white clover plants, and nearly two inches of dead organic matter below the turf, underneath which was dry and apparently worthless soil. Turf treated with basic slag and closely grazed with cattle contained practically no dead organic matter nor wiry bent and fescue grasses, but an abundance of perennial ryegrass and other good grasses, in addition to a luxuriant growth of wild white clover; the soil underneath appeared a good sandy loam, dark in colour, with rich organic matter and moisture. Another specimen of turf was from a strong, clay loam on Davy Houses Field. No perennial ryegrass or wild white clover had been sown for 25 years, but basic slag treatment was commenced in 1903, and close grazing has been practised. The turf is a valuable grazing herbage, possibly as nutritive as can be obtained, and consisting almost entirely of perennial ryegrass and wild white clover.

COMMERCIAL MUSHROOM CULTIVATION.

HITHERTO the cultivation of mushrooms has been considered highly speculative, but recent experience and the knowledge gained by research now make it possible to grow fair crops with a greater element of certainty. Even the most experienced growers, however, are liable to failure, and the beginner should not be tempted by a small initial success to embark on mushroom growing on a large scale. Nevertheless, mushroom growing within small limits may be made a useful adjunct to a nursery or market garden, and even if failure should result, the manure used may still be turned to account for other crops, so that the only loss is that of the cost of labour and spawn.

There are three stages in the life of a mushroom: (1) spores, (2) mycelium or spawn, (3) mushroom. The spores may be seen with the microscope on the under side of the fully developed mushroom. These, when matured, fall off and are carried away by the wind. Under suitable conditions the spores develop into spawn in some favourable medium such as stable manure. In making ordinary commercial spawn, cakes measuring 9 in. by 6 in. by 4 in. are pressed from a wet mixture of horse manure, cow dung and loam, and in each of these cakes several small pieces of virgin spawn are embedded. The cakes so prepared are then stacked in a shed and covered with hot dung, producing a temperature and atmosphere suitable for the growth of the mycelium. When the spawn has spread through the whole of the cake, the pieces are loosely stacked and dried ready for sale or use. The final stage of development occurs in the bed where the mycelium, having spread through the dung, forces its way through the covering of soil, and forms small groups of nodules, some of which develop into mushrooms. Normally the production of mushrooms continues until the supply of nitrogenous matter contained in the dung runs short.

Intending growers will be well advised to buy spawn ready made from a manufacturer of good repute. Spawn is sold by the bushel of 16 cakes, one bushel being required for every 2½ tons of dung. It should be bought dry, and a cake, when broken into pieces, should show the white threads of mycelium throughout the whole cake. Full instructions for the preparation of manure intended for mushroom beds will be found in the Ministry's Leaflet No. 276, copies of which may

be obtained on application, free of charge, to the General Secretary, 3, St. James's Square, London, S.W.1. The leaflet describes also the methods of indoor and outdoor culture.

For indoor culture any place that provides an agreeable temperature and is free of draughts, can be used. Cellars, barns, stables, wooden sheds, disused tunnels, quarries, vineries and cucumber houses can all be successfully adapted for mushroom cultivation. The roof and sides of wooden sheds should be covered with a thick thatch of straw, and provision made for ventilation in the roof. It is also an advantage to instal hot-water pipes. If vineries are used the flat beds should be on the pathway, with at least 3 ft. of the vine border left clear. The same rule applies to cucumber houses. In each case a raised plank should be provided, so that the crop may be picked without the operator setting foot on the bed. Ridge beds may be made in very wide greenhouses. Except in glasshouses, indoor beds may be made at any time of the year; the beginner should, however, avoid commencing his preparations during the months of May, June and July.

For outdoor cultivation of mushrooms the selection of a site is a matter of importance, especially if the crop under cultivation is to be on a large scale. Among the essentials are natural shelter from cold winds and a good supply of loam or sandy loam for the casing of the beds; adequate drainage is also necessary. Shelter from cold winds may be increased by the use of high wind breaks made of straw or straw mats, and it is of advantage to have an ample supply of straw within easy distance. September, October, December and January are the usual months for making up outdoor beds. The September and October beds should start to bear in December and continue until March, and the second will commence in March and finish in June. It is well not to attempt summer cultivation until the grower has attained considerable experience. The leaflet mentioned gives detailed instructions for the construction of flat and ridge beds, the preparation of which is a rather elaborate operation. The question of temperature is also very important, and in this there is a considerable difference of opinion. When the beds are properly made up, the manure develops a temperature rising from 86° F. to about 140° F. This temperature then falls, and when it has dropped to 85° F. in flat beds and 80° F. in ridge beds, the time has come for spawning to begin. If the temperature is allowed to drop to 75° F. it is possible that the spawn will either not develop at all or only develop very slowly. Mushrooms

should begin to appear in from 6 to 8 weeks, but even if this time is exceeded, hope need not be given up, as a little extra covering or additional heat may still bring the crop along. Beds that have lain dormant for more than three months have, in the end, been known to yield a heavy crop. In normal circumstances, the bed will need to be picked over three times a week, but the frequency of picking is regulated by the progress of the crop.

In picking mushrooms for market, the contents of each basket should be made up to even weights, usually 5 or 6 lb., good weight being allowed to compensate for evaporation in transit. Packing with the stems upwards prevents the spores falling on the mushrooms below and spoiling the colour. For the sake of appearance, however, the top layer may be packed with the stems downwards. Baskets should be marked "Perishable. Mushrooms, With Care," and should be covered with tough brown paper and tied down with strong twine. The marketing of mushrooms is helped by grading, a comparatively simple affair. The chief recognised grades of mushrooms are (1) buttons, (2) cups, (3) broilers, (4) roughs. Buttons are the mushrooms which have not opened. Cups are partly open, broilers are fully opened, and roughs are broken and imperfect specimens rejected from the other grades. An experienced grower can obtain an average crop of 40 lb. to one ton of manure used. Since the War, the increase in the price of materials has made it impossible to raise a crop of mushrooms for less than 30s. to 40s. per ton of manure employed. The increase in prices, however, has kept pace with the costs of production, and the rates obtaining during 1919 at Covent Garden showed that cultivation might still be carried on on economic lines, although no hard and fast rules can be laid down as to the prices likely to obtain in the future.

FEEDING STUFFS IN OCTOBER.

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SINCE last month, cereal feeding stuffs are slightly cheaper, but oil seed cakes on the other hand are slightly dearer. The cheapest cereals are maize and coarse middlings, which now cost only a fraction over 2d. per pound of starch equivalent. Palm kernel cake has gone up steadily in price since the early summer, when it was only £8 per ton. It is still, however, the cheapest concentrated feeding stuff on the market, costing even at its present price of £12 10s. per ton slightly under 1½d. per pound of starch equivalent.

During the month several correspondents have inquired as to the digestibility of certain feeding stuffs for young animals. The digestibility figures on which the starch equivalents given in the Table are based have been determined in all cases by experiments on adult animals. There is no definite knowledge available as to the digestibility of feeding stuffs for young animals. In the present state of our knowledge the only safe way of feeding young animals is to include in their diet only those feeding stuffs which experience has shown to give good results. These foods will no doubt vary considerably in the cost per pound of starch equivalent; the Table will show which of them are cheaper.

The description of the manufacture of fish meal given in last month's Notes was not quite clear in all details. For making fish meal for feeding purposes, only white fish is used. This kind of fish contains only a small proportion of oil, and extraction of the oil is therefore not necessary.

The discrepancies between the results obtained by various experimenters with palm kernel meal have given rise to many inquiries. So far as the writer can determine, the discrepancies are due to the fact that two kinds of palm kernel meal are on the market. Palm kernel cake meal, that is to say, palm kernel cake (made by *pressing* out the oil) which has been finely ground to meal, has always given good results. Palm kernel meal made by grinding the raw material and extracting the oil chemically is a much less satisfactory feeding stuff. It contains only about 1 per cent. of oil, whereas the ground cake contains 6 per cent. Buyers should see that they get palm kernel *cake* meal.

NAME.	Price per Qr. s.	lb.	Price per Ton. £ s.	Manurial Value per Ton. £ s.	Food Value per Ton. £ s.	Starch Equiv. per 100 lb.	Price per Unit Starch Equiv. s.	Price per 1 Starch Equiv. d.
Barley, English Feeding	80/-	400	22 6	1 6	21 0	71	5/11	3·16
„ Foreign -	75/-	400	21 0	1 6	19 14	71	5/7	3·09
Oats, English -	60/-	336	20 0	1 9	18 11	59·5	6/3	3·37
„ Foreign -	57/-	320	20 0	1 9	18 11	59·5	6/3	3·37
Maize - - -	75/-	480	17 10	1 5	16 5	81	4/-	2·35
Beans, English spring -	120/-	532	25 0	3 1	21 19	66	6/8	3·61
„ „ winter -	108/-	504	24 0	3 1	20 19	66	6/5	3·56
„ Chinese -	20/-	112	20 0	3 1	16 19	66	5/2	2·77
Peas, English blue -	110/-	504	24 10	2 13	21 17	69	6/4	3·50
„ „ dun -	100/-	504	22 5	2 13	19 12	69	5/8	3·04
„ „ maple -	115/-	504	25 10	2 13	22 17	69	6/7	3·44
„ Japanese -	140/-	504	31 10	2 13	28 17	69	8/4	4·78
Buckwheat - -	—	—	—	—	—	—	—	—
Rye, English -	80/-	480	18 10	1 8	17 2	72	4/9	2·77
Millers' offals—Bran -	—	—	14 10	2 10	12 0	45	5/4	2·89
„ „ Coarse middlings	—	—	15 10	2 10	13 0	64	4/1	2·15
Barley meal - - -	—	—	24 0	1 6	22 14	71	6/11	3·72
Maize „ - - -	—	—	19 0	1 5	17 15	81	4/5	2·47
Bean „ - - -	—	—	22 10	3 1	19 9	66	5/11	3·14
Fish „ - - -	—	—	25 10	7 12	17 18	53	6/9	3·62
Cakes, Linseed - -	—	—	23 10	3 12	19 18	74	5/5	2·90
„ Soya - - -	—	—	—	—	—	—	—	—
„ Cotton seed -	—	—	14 0	3 5	10 15	42	5/2	2·77
Cotton seed decorticated	—	—	21 10	5 6	16 4	71	4/7	2·47
„ decorticated meal	—	—	21 10	5 6	16 4	71	4/7	2·47
Coconut - - -	—	—	14 10	3 0	11 10	79	2/11	1·56
Groundnut - - -	—	—	16 5	3 9	12 16	57	4/8	2·59
„ decorticated	—	—	20 0	5 5	14 15	73	4/1	2·19
Palm kernel - -	—	—	12 10	2 1	10 9	75	2/9	1·47
„ „ meal -	—	—	12 15	2 1	10 14	75	2/10	1·53
Brewers' grains, dry -	—	—	12 0	2 7	9 13	49	3/11	2·89
„ „ wet -	—	—	0 18	0 12	0 6	15	0/5	0·27
Distillers' „ dry -	—	—	14 0	2 16	11 4	57	3/11	2·19
„ „ wet -	—	—	1 0	0 13	0 7	16	0/5	0·22
Malt culms - -	—	—	10 0	3 6	6 14	43	3/2	1·79

MANURES IN OCTOBER.

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THE opening of the season 1920-21 finds the farmer still faced with some of the old war-time problems; the need for increased production is as insistent as ever: more corn is needed; not less, and if possible more, land is wanted under the plough. Agriculture is rapidly advancing in importance in the national economy. Fortunately, the labour supply in many districts is sufficient to allow an energetic programme to be carried out, and there is a good, though perhaps not an over large, supply of fertilisers.

Storing Artificials.—Farmers who can store fertilisers will do well to lay up stocks for the season and to obtain their autumn and spring dressings as early as convenient. Three classes of fertiliser will be needed:—

For the grass land.—Basic slag; a trial may also be made with ground mineral phosphates.

For the corn.—Nitrate of soda and sulphate of ammonia; a trial if desired with nitrate of lime or with nitrolim.

For green crops fed to animals, for mangolds, swedes, &c.—Superphosphate.

For potatoes, mangolds, and on light soils for clover and oats.—Potassic fertilisers, in addition to phosphates and nitrogenous fertilisers.

Quantities required.—There is no doubt that high farming is the best and soundest line to adopt, and that a liberal use of fertilisers is advantageous both to the individual and to the community. The following quantities may be used:—

Basic slag.—Up to 7 or 8 cwt. per acre of present-day grades for grass land which has not been slagged for the past four years.

Nitrogenous fertilisers, nitrate of soda or sulphate of ammonia.—About 1 cwt. per acre for second straw crops, and for all other corn crops except those grown after roots fed off with fairly good supplies of meal or cake. *Nitrate of soda* up to 2 cwt. for mangolds, cabbage. *Sulphate of ammonia* up to 2½ cwt. for potatoes.

Superphosphate.—About 2 cwt. per acre for corn that is likely to want help; from 3 up to 5 or 6 cwt. for root crops grown for sheep or cattle, and for potatoes. Less will be required where farmyard manure has been used.

Potassic fertilisers.—2 cwt. per acre of sulphate or muriate of potash for mangolds, potatoes, and on light soil or chalk soil for corn or clover needing help, or for grass laid in for hay.

Basic Slag.—Some of the fertilisers are not quite the same as those to which the farmer was accustomed before the War. Probably the greatest change is in basic slag. Before the War the usual high grade standard was about 40-43 per cent. phosphate, of which 80 per cent. or more was soluble in 2 per cent.

citric acid, ground to such a fineness that 80 per cent. or more passed through a sieve containing 100 meshes to the linear inch. The slag now available to the farmer is different, and the position is more complex. There are three different grades :—

1. The pre-war slag—the so-called Bessemer slag—of which there may be some, but not a great deal.
2. A lower grade containing phosphorus equivalent to 15-30 per cent. of tri-calcic phosphate, 80 per cent. being soluble in 2 per cent. citric acid. There is a considerable quantity of this. It is often described as low grade high soluble slag.
3. A still lower grade, containing phosphorus equivalent to 15-20 per cent. of tri-calcic phosphate, but largely insoluble in 2 per cent. citric acid—less than 20 per cent. usually dissolving. A considerable amount of this is obtainable ; it is sometimes described as fluor-par slag, but more usually as low grade low soluble slag.

To some extent farmers may have to accept whichever of these grades they can obtain. The change in character of the slag has been going on for several years, but it came into prominence during the War, and is permanent. Agricultural experts in various parts of the country are testing the new materials and are obtaining reliable information for farmers. Meanwhile, farmers who are offered a choice of slags will do well to consult their County expert.

Where supplies of slag cannot be obtained it will be well to inquire from the County expert into the possibility of obtaining suitable mineral phosphates. The name and address of the County expert can be obtained on application to the Ministry of Agriculture, Whitehall Place, S.W.1.

Potassic Fertilisers.—The position in regard to potassic fertilisers is somewhat interesting. The three pre-war fertilisers are all obtainable: the sulphate, the muriate and kainit. Of these the sulphate comes from Germany while the muriate and kainit come from Alsace and Lorraine, in addition to the German supplies. So far as is known the Alsatian mines cannot produce sulphate, for which the Stassfurt deposits will always have an advantage. Whether any British potash will find its way on to farms remains to be seen. The qualities are at least as good as before the War, and some of the French muriate is better than the pre-war material. The potash in pre-war muriate was usually equivalent to 45 per cent. of pure potash (K_2O), while that in the Alsatian muriate is equivalent to 50-60 per cent. of pure potash. There is no doubt that the enterprising French company which has undertaken the development of the resources of Alsace-Lorraine will make the best of their potash supplies.

It is a little difficult to make a choice between the two substances; sulphate of potash is always safe in use, and there are cases where the muriate is said to have been inferior or even to have caused trouble. No authentic case of inferiority has come to the writer's notice, and no doubt careful test experiments will before long be made. For mangolds, grass and corn the muriate is in all probability just as useful as the sulphate; for potatoes and for tomatoes under glass it might conceivably be less useful, though no definite rule could be made without detailed experiments.

Nitrogenous Fertilisers.—The nitrate of soda is as before the War; the sulphate of ammonia may in some cases be better where more efforts are being made to remove adhering acid. There may be larger supplies than hitherto of the synthetic fertilisers, nitrate of lime and nitrolim, and farmers may also be offered trial lots of ammonium nitrate and ammonium chloride.

Lime.—None of the fertilisers described above does away with the necessity for the use of lime. The two best indicators of the need of this substance are:—

1. Failure of clover in patches, except where definite disease is present;
2. Finger-and-toe on the swedes and turnips.

Both these will be showing during the next few weeks. Where the need is established every endeavour should be made to meet it: much time and money may be lost in attempting to cultivate sour land, and there is no short and easy way of avoiding the use of lime. Agricultural committees looking for relief work might well organise the liming and chalking of areas of sour land—work that would be much more remunerative than some that is usually proposed; and if, happily, the need for organised relief never arises, they can start liming or chalking associations among farmers on the lines adopted in some of the Continental countries.

Farmyard Manure.—When all is written about artificial manures and lime, however, farmyard manure remains the commonest and the most popular manure on the farm, and unfortunately it is often the most neglected. It used to be valued at about 4s. or 5s. per ton; at present prices it can hardly be worth less than 15s. or 20s. If well made and well stored it may even exceed 20s. per ton in value, but bad making and bad storage may pull the value below 15s. and also reduce the quantity. Every care should be taken of the farmyard manure.

NOTICES OF BOOKS.

Modern Pig Feeding.—(Cambridge: School of Agriculture and Institute of Animal Nutrition.) This pamphlet deserves to be read carefully by every feeder of pigs. Mr. K. J. J. MacKenzie, the University Reader in Agriculture and Director of the University Farm, and Mr. John Fleming, give an account of four years' experiments in producing bacon on war-time rations, that is, rations in which anything that could possibly be used directly for human food was absent. For an account of the methods adopted in thus weaning, rearing and fattening pigs, and for opinions expressed by various experienced housewives regarding the resulting bacon, readers should consult the pamphlet itself, which may be obtained for the cost of postage (2d.) from the Secretary, School of Agriculture, Cambridge. It can also be obtained by agriculturists resident in the counties in the Eastern Province, by applying either to County Secretaries for Education, or County Agricultural Organisers.

The main form of concentrated food was palm kernel cake, which was used with success for the feeding of breeding sows, for weaning and rearing young pigs (to which it was given crushed into meal) and for fattening hogs. As palm kernel cake is at present one of the cheapest feeding stuffs on the market, and as prices still preclude any return to pre-war standards of feeding, the value of Mr. Mackenzie's and Mr. Fleming's work is evident.

Two other points of great practical importance, to which Professor T. B. Wood refers in his interesting preface, are: (1) The striking effect of a small addition of dried blood to the palm kernel ration of young pigs: and (2) The great effect caused by adding maize to palm kernel cake in fattening bacon hogs. It would seem probable that the dried blood provided the vitamines absent from the palm kernel cake, and when it came to fattening, the maize supplied the fat factor, which was much needed, owing to the deficiency of carbohydrates. These points, however, by no means exhaust the interest of this little pamphlet, which is stored with practical wisdom. The pages dealing with grazing also deserve very careful reading.

Insect Pests and Fungus Diseases.—P. J. Fryer. (London: Cambridge University Press, 1920, 45/- net.) This volume contains elementary explanatory material on insects and plant structure, and deals also with various insect and other pests on the zoological side attacking fruit and hops. It is divided into two parts. Part I. deals with the insect pests and insecticides, and Part II. with fungus diseases and their control.

The information is classified under headings, dealing with preventive measures, remedies and a calendar of treatment, followed by sections treating fully with insecticides and fungicides and their use. Useful tables are given for estimating the quantity of insecticide required. A few pages are devoted to insects beneficial to agriculture.

There is a section on spraying appliances and methods, followed by a copious spraying calendar, tables of weights, measures and capacity, pest duration, &c. The book is indexed and fully illustrated, including some coloured plates. The photographic illustrations, together with Plates 5 to 8 taken in colour directly from the insects, will prove useful for diagnosis and identification.

The author of this volume is the chemist to the Yalding Manufacturing Company.

Rothamsted Memoirs on Agricultural Science, Volume IX., 1909-1916.—(Harpenden: Rothamsted Experimental Station, 1919, 35s. net.) These Memoirs, recently published, consist of a series of reprints of articles contributed by scientific workers at Rothamsted to various agricultural and scientific papers (chiefly the *Journal of Agricultural Science*). They also contain a report of an address delivered to the British Association for the Advancement of Science by Dr. E. J. Russell, F.R.S., Director of the Station, in 1916. Thirty-eight reprints in all are included in the Memoirs, and the subjects dealt with cover micro-organisms of the soil, biological conditions in the soil, weeds, rain water, and the carbohydrates in plants. The Volume is handsomely bound, and should be very useful to students of agricultural science for the purposes of study and general reference.

The Report of the Progress of the Ordnance Survey for the Year 1919-20.—(London: H.M. Stationery Office, 1920, price 1s. net). This report gives an account of the activities of the National Survey during the first year since the date of the Armistice. The importance of the work done, and its value to British farmers, is perhaps not generally realised, but the Department, by the issue of Ordnance Survey maps covering the entire surface of the United Kingdom, has done much to assist the interests of British agriculture.

Maps on the scale of 6 inches to one mile and on the still larger scale of 25 inches to one mile are available for the whole surface of the United Kingdom, except waste and mountainous areas. Copies may be obtained at all the principal booksellers, or direct from Southampton.

It is these large scale maps, particularly those on the scale of 25 inches to one mile, that are so useful to owners of property, estate agents, farmers and all who have to deal with agriculture and the land. For the price of a few shillings every owner or tenant can obtain an accurate plan of his property, on which every field and enclosure is represented, and on which the acreage of every enclosure is given.

The large scale maps are periodically revised. As would be expected, the greater number of changes occur near growing towns and villages; the features of agricultural England change but slowly; but even the maps of agricultural regions are revised every 20 years. The revision of the large scale maps is at present proceeding in Derby, Durham, Essex, Gloucester, Northumberland, Oxford and Yorkshire. It should be noted that the maps of the agricultural districts of those counties which have not been recently revised are substantially perfect, and no one need hesitate to buy a large scale map on the ground that the revision is a few years old.

The information given by a 25-inch Ordnance map is, briefly, the following:—The position of every fence, hedge, wall, ditch, river, stream, canal, road, path and railway; the position and shape of every house, out-building, wood, copse or orchard; the acreage of every parcel of land or enclosure; the heights above sea level of important objects and surfaces; the boundaries of civil parishes, boroughs, wards and unions, urban and rural districts. The map, indeed, gives a vast amount of information which could only be obtained from other sources with difficulty and at considerable cost.

Perhaps enough has been said to indicate the value to the agricultural community of the large scale Ordnance Survey, especially of the 25-inch maps.

They should be in the possession of property owners and farmers, and of all interested in the management of land. If any difficulty should be experienced in obtaining locally the 25-inch maps covering a farm or an estate, application should be made to the Director-General, Ordnance Survey, Southampton.

Sulphate of Ammonia: Increased Prices.—Owing to the increase in railway rates, which came into force on 1st September, 1920, the Ministry has sanctioned an increase in the agreed maximum prices for sulphate of ammonia by 3s. 6d. per ton. This applies to all deliveries made on or after 1st September, except when deliveries are in fulfilment of existing contracts in which no provision is made for a possible increase of price in the event of railway rates being raised. The original prices remain in force for deliveries made ex-works or by road.

A leaflet explaining these alterations is obtainable post free on application to the General Secretary, Ministry of Agriculture and Fisheries, 72, Victoria Street, London, S.W.1.

Basic Slag: Increased Prices.—Owing to the increase in railway rates which came into force on the 1st September, the Ministry has sanctioned an increase of the agreed maximum prices for basic slag (see this *Journal*, June 1920, p. 297) by 3s. 6d. per ton from the 1st September. The original prices remain in force for deliveries made ex-works or by road.

A leaflet explaining these alterations may be obtained post free on application to the General Secretary, Ministry of Agriculture and Fisheries, 72, Victoria Street, London, S.W.1.

Sale of Cereal Seed.—The attention of farmers and seed merchants is drawn to the fact that when selling wheat, barley, oats or rye for seed it is necessary, under the Testing of Seeds Order, 1918, that the seed shall be tested for germination, and that a declaration giving the following particulars shall be made in writing to the purchaser within one month of sale or delivery:—

1. The name and address of the seller.
2. The variety.
3. The percentage of germination.

If, however, the germination is at or above the standards specified in the Order, viz.:—

90 per cent. for wheat and barley,
85 per cent. for oats,
80 per cent. for rye,

a statement to that effect is sufficient, but if the germination is below these figures the actual percentage must be declared.

4. The date of the germination test (if made more than six months previous to sale).

It should be noted that this declaration is required in the case of a sale of cereal seed from farmer to farmer as well as from seedsman to farmer. No declaration need be made as to the percentage of purity in the case of cereal seed.

Failure to make the above declaration is a summary offence against the Defence of the Realm Regulations.

Samples of cereal seed intended for sale are tested at the official Seed Testing Station, 18, Leigham Court Road, Streatham Hill, S.W.16, for 1s. per sample. The sample sent for testing should not be less than 4 oz.

Examination of Live Bees suspected of Disease.—It is not generally known that arrangements exist at the Ministry's Bee Disease Investigation Department for the examination of live bees suspected of disease. Bee-keepers who wish to have bees examined should pack them in accordance with the instructions given on the prescribed form, No. 13.H.C., which can be obtained from County Education Committees, and should answer fully the questions regarding the history of the stock from which suspected bees were taken. Bees for examination should be sent to Dr. Helen Goodrich, The Department of Comparative Anatomy, University Museum, Oxford. The Ministry desires to emphasise the fact that *live* bees only are of any use for purposes of microscopical examination, as decay sets in very rapidly after the bees have died.

Precautions against Cattle Plague.—The Ministry announces that, owing to the appearance of Cattle Plague or Rinderpest in Belgium, an Order will come into effect immediately by which cattle, sheep, goats and swine from Belgium will not be permitted to enter British ports in future, whether as ships' stores or otherwise. Similar restrictions also apply to these animals when carried on vessels touching at Belgian ports *en route* to Great Britain, irrespective of whether the animals were actually shipped at a Belgian port or not. Hitherto, the above animals were permitted under certain circumstances to enter a British port, provided they were not landed and that the ship carrying them did not discharge or load cargo.

Importation from Belgium is also prohibited of feeding stuffs for animals (including milling offals, meals, cakes, &c.) and also of the following animal products, viz., wet hides, hoofs, horns, bones, hair of bovine animals, dried blood, beef and pork. This prohibition applies to all such products, not only of Belgian origin but to those which may be brought through Belgium by river, canal or otherwise from any adjoining country. From the start the Belgian Authorities have themselves prohibited the export of many of these materials, but it is thought advisable to provide against the possibility of premature removal of this prohibition by an Order prohibiting importation. Any of these products which are brought into a Belgian port by sea for the purposes of transhipment to Great Britain may, however, be landed in this country if accompanied by a licence granted by a British Consul at the port of transhipment in Belgium on the production to the Consul of satisfactory evidence that the articles have been taken into a Belgian port by sea solely for the purposes of transhipment.

The Ministry at the same time again calls attention to the possible risk of the introduction of Cattle Plague as well as of Foot-and-Mouth Disease by means of hay and straw used at the time of importation as a packing for foreign imported goods. Numerous imported articles, such as eggs, glass and pottery, are packed in hay or straw and a large portion of this packing may ultimately reach the farm as manure. This hay and straw constitutes a possible source of risk of the introduction of disease to the farm live stock. While the Ministry does not see its way to prohibit the use of this material as packing for imported goods owing to the serious dislocation which would result to trade, it is important that all concerned should be warned that there is at least an element of risk which can be completely avoided by not allowing it to come in contact with any animals.

The losses which would result from any widespread outbreak of either Cattle Plague or Foot-and-Mouth Disease in this country would seriously affect the general public, and the Ministry appeals to manufacturers and traders and all who receive hay and straw as a packing for foreign imported goods to take the necessary steps to prevent this packing material being sent to farms or other places, where it could possibly come in contact with live stock, and instead to make arrangements for such material to be destroyed by burning.

Leaflets issued by the Ministry.—Since the date of the list given on page 594 of last month's issue of the *Journal*, the following leaflets have been issued in the *Permanent Series* :—

No. 334.—How to Increase Stocks of Bees. (Formerly Food Production Leaflet No. 48.)

„ 352.—The Control of Pests of Fruit Trees in Gardens and Small Orchards. (Formerly Food Production Leaflet No. 39.)

In addition, the information in the following leaflets has been revised and brought up to date :—

No. 22.—The Diamond-back Moth.

„ 151.—Cleanliness in the Dairy.

„ 180.—Dodder.

„ 250.—Domestic Fruit Bottling with or without Sugar.

„ 254.—The Use of Seaweed as Manure.

„ 323.—The Profitable Utilization of Surplus Milk.

Jam-making with Brown Sugar.—The Ministry wishes to draw attention to the possibility of using brown sugar for jam-making. There are in different parts of the country at the present time stocks of free brown sugar which are being sold at prices ranging from 10½d. per lb. upwards. This sugar, when used with white sugar in the same proportion as recommended in the Ministry's Leaflet No. 354 for glucose, viz., ¼th "free" brown sugar to ¾ths white sugar, gives better results than glucose, and in some cases is cheaper. Even if a larger supply of brown sugar is available, it is not advisable to use more than one-third of brown sugar, as in most jams, with the exception of black currant, the flavour of the fruit would be considerably affected.

Exportation of Seed Potatoes to Holland.—The Ministry of Agriculture desires to draw the attention of potato exporters to the regulations which the Netherlands Government proposes shortly to issue for controlling the importation of potatoes into Holland. The Ministry is informed that, under these regulations, potatoes imported into Holland must have been inspected at the time of lifting on the field where they were grown, and must be free from Wart Disease. A certificate to this effect must be issued, as regards potatoes grown in England and Wales, by an Inspector of the Ministry, who must also be present when the potatoes are bagged. Only new bags may be used for this purpose, and they must be sealed by the Inspector, who will then issue a certificate that the potatoes contained in the bag were grown on the inspected field. Persons wishing to export seed potatoes to Holland should, therefore, inform the Ministry immediately when it is proposed to lift any crops destined for export, in order that arrangements may be made for an Inspector to be present. The fee for inspection and issue of the certificate will be £1 1s.

Rabies.—*Wiltshire.*—On the 14th August an outbreak of Rabies was confirmed at Wilton, near Salisbury, a district not hitherto visited by this disease.

This outbreak necessitated the imposition of muzzling and movement restrictions over a wide area embracing parts of the counties of Wiltshire, Hampshire and Dorset, and extending approximately from Bournemouth in the south to Wroughton in the north and from Winchester in the east to Maiden Bradley in the west. Subsequently, eight further cases were confirmed, one at Marlborough, four at Salisbury, one at Netheravon, one at Burbage and one at Potterne, near Devizes.

In view of the case at Marlborough and the additional cases in and near Salisbury, the area originally scheduled was extended so as to include the district lying within a radius of approximately 15 miles from Marlborough, and an Inner or Dangerous Area, comprising the district lying within 5 miles of Wilton and Salisbury, was declared. In this Inner Dangerous Area dogs are required to be led as well as muzzled in a public place, and also muzzled on private premises unless tied up or confined in an enclosure from which they cannot escape, and no exemptions are allowed for dogs used for hunting or other sporting purposes. Dogs are also not allowed to be moved out of this Inner Area, even to the outer zone of the Muzzling Area, without a special licence from the Ministry entailing six months' quarantine on approved veterinary premises.

The confirmation of the cases at Netheravon and Burbage, both of which lie between Marlborough and Salisbury, necessitated the extension of the Inner Dangerous Area in a north-easterly direction so as to include the whole of the country from Salisbury to Marlborough through which the Burbage dog had run. At the same time the Scheduled District was extended so as to include Andover and certain parishes on the eastern side of the district round Andover.

Glamorgan.—On the 11th September Rabies was confirmed in two fox-hounds at Cowbridge, Glamorgan, in a district which has only comparatively recently been released from restrictions. The usual Order was at once made requiring the muzzling of all dogs in an area comprising roughly a radius of 12 miles round Cowbridge, extending from the county boundary between Monmouth and Glamorgan on the east to Kenfig and Maesteg on the west, and to approximately Caerphilly, Pontypridd and Llangeinor in the north. The Order also prohibited the movement of dogs out of the Area, except by licence requiring six months' quarantine on approved veterinary premises. No further outbreak has yet been confirmed in this Area.

ADDITIONS TO THE LIBRARY.

Agriculture, General and Miscellaneous.

Long, Jas.—The Small Farm and its Management. (2nd Ed.), (Revised), (328 pp.). London: John Murray, 1920, 7s. 6d. net. [63.191.]

Wibberley, T.—Continuous Cropping and Tillage Dairy Farming for Small Farmers. (185 pp.). London: C. Arthur Pearson, 1919, 3s. 6d. net. [63.3(02); 63.70(02).]

Percival, John.—Agricultural Bacteriology. Theoretical and Practical. (2nd Ed.), (408 pp.). London: Duckworth & Co., 1920, 12s. 6d. net. [576.8.]

Sutton, M. H. F.—Bull. 11 :—The Electrification of Seeds by the Wolfrum Process. A Report of the Experiments carried out at Reading in 1919. (7 pp.). Reading : Sutton & Sons, n.d., 2s. 6d. net. [537.]

New York Agricultural Experiment Station.—Tech. Bull. 67 :—Ammonification of Manure in Soil. Pt. I. What Soil Organisms Take Part in the Ammonification of Manure. Pt. II. Taxonomic Study of Two Important Soil Ammonifiers. (45 pp.). Geneva, N.Y., 1919. [63.115; 63.16.]

British Columbia Department of Agriculture.—New Hort. Circ. 61 :—Making Lime Sulphur at Home. (5 pp.). Victoria, B.C., 1920. [63.295.]

Horticulture.

New York Agricultural Experiment Station.—Bull. 460 :—Twenty Years of Fertilizers in an Apple Orchard. (26 pp.). Geneva, N.Y., 1919. [63.42.]

New York Agricultural Experiment Station.—Bull. 461 :—Control of Green Apple Aphis in Bearing Orchards. (38 pp.). Geneva, N.Y., 1919. [63.27-41; 63.294.]

West Virginia Agricultural Experiment Station.—Bull. 167 :—Orchard Spraying Versus Dusting. (18 pp.). Morgantown, 1918. [63.41; 63.294.]

West Virginia Agricultural Experiment Station.—Bull. 170 :—Infection and Immunity in Apple Rust. (71 pp.). Morgantown, 1918. [63.24-41; 63.41(*a*).]

Live Stock.

Kellner, Dr. O.—Die Ernährung der landwirtschaftlichen Nutztiere. Lehrbuch auf der Grundlage physiologischer Forschung und praktischer Erfahrung. (8th Ed.), (667 pp.). Berlin : Paul Parey, 1919. [63.604.]

Nebraska Agricultural Experiment Station.—Bull. 173 :—Supplementary Feeds in Fattening Lambs. (24 pp.). Lincoln, 1919. [63.53.]

U.S. Department of Agriculture.—Farmers' Bull. 1097 :—The Stable Fly (Stomoxys calcitrans L.). How to Prevent Its Annoyance and Its Losses to Live Stock. 23 pp.). Washington, 1920. [59.169(*a*); 63.613.]

Australian Imperial Force Education Service.—Land Book 15 :—The Farm Horse : Its Management, Health and Feeding. (52 pp.). London : A.I.F. Administrative H.Qs., 1919. [63.613.]

Dairying and Food, General.

Orr, Thos.—Milking Machines : Their Efficiency and Value in Modern Dairying. (18 pp.). Reprinted from "The Dairyman," Oct., Nov., and Dec., 1919. London : Offices of "The Dairyman," 1919, 6d. [63.713(04).]

California Agricultural Experiment Station.—Bull. 311 :—Investigations with Milking Machines. (54 pp.). Berkeley, 1919. [63.718.]

Nebraska Agricultural Experiment Station.—Circ. 6 :—Dairy Barn and Milk House Arrangement. (28 pp.). Lincoln : 1919. [63.6; 69.]

Birds, Poultry and Bees.

Root, A. I. and *E. R.*—The A B C and X Y Z of Bee Culture. (836 pp.). Medina, Ohio : A. I. Root Co., 1919. [63.810.2.]

Texas Agricultural Experiment Station.—Bull. 255 :—Beekeeping for Beginners. (25 pp.). Texas, 1919. [63.81(04).]

U.S. Department of Agriculture.—Bull. 810 :—European Foulbrood. (39 pp.). Washington, 1920. [63.81 : 09.]

Economics.

Spencer, A. J.—The Smallholdings and Allotments Acts, 1906-1919, and The Acquisition of Land (Assessment of Compensation) Act, 1919, with Explanatory Notes. (2nd Ed.), (284 pp.). London : Stevens and Sons, 1920, 10s. net. [347(*b*).]

Adkin, B. W.—A Handbook of the Law relating to Landlord and Tenant. (4th Ed.), (Revised). (286 pp.). London : The Estates Gazette, Ltd., 1918. [333.5; 333.6.]

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